GHURRAT AL-ZIJAT
OR
KARANA TILAKA

A Handbook of Astronomy

By

Bijayanand of Benares

Translated From the Original into Arabic
With an Exposition of the
Underlying Principles

By

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AL-BERUNI

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INSTITUTE OF SINDHOLOGY
UNIVERSITY OF SIND
SIND, PAKISTAN.
1973

Institute of Sindhology Publication No. 26

Copies 1000

November, 1973

Price: Rs. 75.00

Can be had from
The Institute of Sindhology
University of Sind
New Campus Town,
Sind, Pakistan.

Printed by Aijaz Mohammed Siddiqui at the Sind University Press,
Hyderabad Sind and published by Dr. Ghulam Ali Allana,
Asst. Director, Institute of Sindhology, University of Sind.
New Campus Town, Sind, Pakistan.

PRODUCED UNDER THE PAKISTAN-BASED PART OF
THE UNESCO PROJECT ON THE CENTRAL ASIAN PEOPLES'
CONTRIBUTION TO SCIENCE

PUBLISHED IN

1973

BY THE INSTITUTE OF SINDHOLOGY

UNIVERSITY OF SIND

IN COMMEMORATION OF

THE MILLENARY CELEBRATIONS OF

AL-BERUNI'S

BIRTH IN

973

PREFACE

While working on the early Islamic period of the history of Sind and checking on Al-Beruni's works, I came across references to the present work in the writings of Dr. M. Nazim and Sayyid Abu Zafar Nadvi. It was in 1954 that with the approval of the late Vice-Chancellor Allama I.I. Kazi of the University of Sind, two photo copies of the manuscript were secured through the kind offices of the late Kazi Ahmad Mian Akhtar of Junagadh, who was then Professor of History at the University. While one copy was used by me for deciphering the text, the other was entrusted to Mr. Fazluddin Qureshi (then on the staff of the Physics Department of the University) for translating it into English. The text and the translation were proposed to be published simultaneously. After a lapse of some 20 years, it was learnt from Mr. Qureshi this year that he had now completed the translation which was being published by the University of the Punjab, Lahore.

It was, therefore, decided to publish the Arabic Text from the University of Sind to meet the objectives of the Pakistan-based part of the UNESCO Project on the Central Asian Peoples' Contribution to Science and to commemorate the Millenary Celebrations of Al-Beruni's birth (973 A.D.).

During the sixties, this work was noticed by scholars both in Pakistan and India.* A detailed discussion of the text, supplemented by English translation and commentary, was undertaken by Saiyid Samad Husain Rizvi of Pakistan whose contributions appeared in instalments in the different issues of the Quarterly *Islamic Culture* (Hyderabad Deccan, beginning with Vol. XXXVII, No. 2, April, 1963). All the issues containing these

* In India, among others, Dr. M. Nizamuddin referred to it in his article "Al-Beruni: A Pioneer Muslim Scientist", published in the *Arshi Presentation Volume*, New Delhi, 1965.

instalments, however, are not easily available. Besides, Mr. Rizvi has readjusted the original sequence of the different sections of the text and also supplied his own corrections, alterations and additions to it and, thus, *revised* the text. As such, there has remained the need for publishing the original text exactly as obtained in the only extant manuscript of the work.

The present publication has been planned to fulfil this need, and a faithful reproduction of the original has been assured by matching the printed pages with those of the original manuscript. While reading the original, it became obvious that the sequence of some of the pages was disturbed at some stage of rebinding the manuscript, and the new page numbers were marked erroneously in the newly bound copy. This has been corrected, and hence the disparity in some of the page numbers in the photo copy and those in the print.

To make this edition more useful, an appendix has been supplied listing from Al-Beruni's other works, viz. *Kitab al-Hind, al-Qanun al-Mas'udi, Tamhid al-Mustaqarr* and *Ifrad al-Maqal*, the extracts which are based on *Ghurrat al-Zijat* or *Karana Tilaka* (this work).

After most of the text was printed, the issues of the Quarterly *Islamic Culture* (Vol. XXXVII, No. 2, April, 1963 to Vol. XXXIX, No. 2, April, 1965) containing the instalments of Saiyid Samad Husain Rizvi's contributions (including the text, as established by him, up to *his* section 12 of *his* Chapter VI) became available. These were used for recording his corrected or alternate readings while drawing up the 'Addenda'. Later on, personal contacts were established with Mr. Rizvi who kindly supplied his corrected/alternate readings for the remaining part of the text. All these are included in the Addenda.

I am grateful to my teachers Prof. Abdul Aziz al-Maimani and Prof. Y. S. Taherally for their generous help and encouragement at every stage of this work.

Mr. Saiyid Samad Husain Rizvi assisted in projecting his corrected/alternate readings in the Addenda. I thank him for his scholarly cooperation. I thank the staff of the Sind University Library and Mr. M. M. Baig of the Library of the Department of Archaeology, Government of Pakistan, for placing literature on Al-Beruni at my disposal.

20th October, 1973.

N. A. Baloch

INTRODUCTION

It is proposed to introduce this work to the reader under two parts: *Part-I* deals with the original work and its author, and with Al-Beruni's translation of the original into Arabic; while *Part-II* is intended to provide a perspective for Al-Beruni's Indian Studies of which the present work constitutes an integral part.

PART I: THE ORIGINAL WORK AND ITS TRANSLATION

The Manuscript

The only manuscript copy of the work which has come to light so far, is preserved in the Library of the Mausoleum of Pir Muhammad Shah in Ahmadabad, india. The seals affixed on ff. 30/b, 42/b and 67/a indicate that the manuscript was endowed to the library by the "family of Waliullah of Ahmadabad in 1327 H." (1909). Brocklemann has not noticed it among the works of Al-Beruni.[1] The late Dr. M. Nazim and Sayyid Abu Zafar Nadvi were probably the first scholars who discovered this unique manuscript and wrote on it during 1930/31.[2] It runs into 34 folios (1/b to 34/b) and 67 pages, with 19 lines on each page. The date of transcription is not given, and it cannot be said with certainty whether the last leaf of the present manuscript represents the very end of the original work. Judging from the style of the handwriting, it is to be concluded that it was transcribed in the Hijra 9th century or later, but not earlier.[3] As such, this copy is at least four centuries posterior to the first copy made by Al-Beruni

some time during the first half of the 5th century of the Hijra.

The Author

In his introduction to this work, Al-Beruni has recorded the full name of the author as "Bijayānand son of Jayānand, or of Bānārasi".[4] In *Ifrad al-Maqal*, he mentions him as "Bijayānand al-Banārīsi" (sic).[5] He is mentioned by his first name 'Bijayānand' four times in *Kitab al-Hind* and twice in *Ifrad al-Maqal*.[6] Sachau in his English translation of *Al-Beruni's India* has rendered this name into its classical form as 'Vijayanandin'[7] which, perhaps more appropriately, was the name of an ancient astronomer who lived in the 5th century A.D. or earlier.[8] The pronunciation 'Bijayanand' represents the vernacular form which was current in the 10th century[9] when the author of *Karana Tilaka* lived and wrote. Al-Beruni took care to record Bijayanand's full name in order to distinguish him from his predecessor Vijayanandin.[10]

Bijayanand flourished in Benares (Varansi) in the 10th century A.D., and compiled his Karana in 888 Shak-Kala[11]/966 A.D., i.e. some 7 years before the birth of Al-Beruni. As a scholar, his main contribution consisted in writing commentaries on some standard astronomical works, and hence Al-Beruni called him "one of the commentators".[12] His present work *Karana Tilaka* is part of that effort, being essentially a 'made easy digest' based on an earlier standard work *Surya-Siddhanta*.[13]

Status of Karana Tilaka

From Al-Beruni's writings, *al-Zij* (plu. *al-Zijat*) is understood to be 'a handbook of mathematical astronomy.'[14] According to him, the word *Zij* or *Ziq* originated in the

Persian word *Zih*, *i.e.* the bow string[15] which in its setting signified the measure of a chord. In case of the Indian works (*Zijat al-Hind*), every *Zij* invariably dealt with the subject of 'Eclipses'.[16] In his *Canon*, Al-Beruni would appear to be differentiating between the two main categories of the Hindu astronomical works, by employing the differing terminology of *Siddhanta* and *Zijat*.[17] He refers to about a dozen works of the *Zijat* category, belonging to the Greek, Hindu and the Muslim authors. Among the '*Zijat*' of the Hindu authors, he specifically mentions *Zij Khanda-khadyaka* or *Zij al-Arkanad*[18] and the present work *Zij Karana Tilaka.*[19]

The status of *Karana Tilaka* in the Indian astronomical literature can better be judged from Al-Beruni's classification, in his *Indica*, of the astronomical works of Hindu writers. He divides them into two main categories: (i) the *Siddhanta* (lit. *straight*), i. e. 'every standard book on astronomy', though it did not come up to the mark of the *Zij* works of the Muslim astronomers; and (ii) the *Tantra* and the *Karana* works which did not come up to the standard of a *Siddhanta* but occupied a secondary position.[20] Literally, *Karana* means *following*, i.e. "following behind the Siddhanta".[21] In the first category, the following five *Siddhantas* were of primary importance: *Surya-Siddhanta* composed by Lata, *Vasishtha-Siddhanta* by Vishnucandra, *Paulisa-Siddhanta* by Paulisa (the Greek), *Romaka-Siddhanta* by Srishena, and *Brahma-Siddhanta* by Brahmagupta.[22]

In the second category, Al-Beruni mentions four works of the *Tantra* type, and more than a dozen works of the *Karana* type, beginning with the mention of *Karana Khanda-khadyaka* of Brahmagupta (representing the doctrine of Aryabhatta), the *Karana* works of Sugriva (the Buddhist) and

his pupils, then *Karana Tilaka* of Bijayanand, and lastly a number of other works.[23]

Notwithstanding the order in which it is mentioned, Al-Beruni regarded *Karana Tilaka* prominent among the *Karana* compilations. Its author had rightly called it '*karana tilaka*'[24] which was translated by Al-Beruni under two different titles: (i) as *Ghurrat al-Zijat*,[25] i.e. 'the premier one among the *Zij* astronomical handbooks', and (ii) as *Ghurrat al-Tawabi*,'[26] i.e. 'the premier one among the *Karana* compositions *which follow* (the *Siddhantas*).[27]

This raises the question as to which earlier standard work was followed by Bijayanand while compiling *Karana Tilaka*? In other words, on which earlier Siddhānta is *Karana Tilaka* based? Saiyid Samad Husain Rizvi, on the basis of his critical evaluation of the contents of *Karana Tilaka* has concluded that it "is entirely based" on the so-called "modern Suryasiddhanta" and that even its *ahargana* is based on the "modern Suryasiddhanta".[28] According to him, "the real importance of *Karana Tilaka* lies in the fact that it is a missing link between *Karana Khanda-khadyaka* of Brahmagupta and *Karana-kathala* of Bhaskaracharya" and "a connecting link between the old and the modern Suryasiddhantas",[29] and that it also occupies "an intermediate position between Suryasiddhanta and Brahma-sputa-Siddhanta".[30] According to Al-Beruni, the method of calculating the *ahargana* in the *Khanda-khadyaka* and *Karana Tilaka* is the same.[31]

Al-Beruni's own observations on the value of *Karana Tilaka* are revealing. He points out in his introduction that this work though 'small in size is of immense value, being equally useful to the advanced scholars and the beginners'.

Referring to a calculation given in it, he confirms that "this calculation is correct".[32]

He considered it valuable enough to be translated and important enough to be quoted in at least four of his works on the different problems of astronomy. In *Kitab al-Hind* Al-Beruni has referred to it ten times, specifically quoting from it on: a method for the computation of the longitude of a place and of the corrected circumference of the earth (I/313-14); on the dominants of year, month, and *hors* (I/343-44); on the *ahargana* rule (II/49-50); on the computation of the mean places of the planets (II/60); on the computation of the diameter of the sun (II/79); on the circumpolar stars and their distance from the sun (II/90); on the method of calculating the *vyatipata* and *vaidhrita* (II/206, 208); and on the twenty seven *yogas* and the method of their computation (II/209). In *al-Qanun al-Mas'udi* (pp. 973 & 1313), it has been cited on the measures and conjunctions of the planets. In *Tamhid al-Mustaqarr fi Tahqiq ma'na al-Mamarr*, it has been quoted on the computation of the mean places of the planets (pp. 27-28 & 32). In *Ifrad al-Maqal fi Amr al-Zilal*, it has been quoted on the correction of the line of meridian by two equal shadows or directions (p. 107), on the durations of day and night and ascensional differences (p. 136), and on calculating the past and the remaining duration of the day by means of shadow (p. 152).

Al-Beruni's Translation: The Date

In absence of the concluding part of the text containing Al-Beruni's statement (if any) regarding the completion of the work, it is difficult to say when he had acquired or translated this Karana. From amongst the published works of Al-Beruni, it is cited in at least four of them: *Ifrad al-Maqal*, *Tamhid al-Mustaqarr*, *Kitab ma li al-Hind* (*Indica*), and *al-Qanun*

al-Mas'udi (*Canon*). In each of the first two works, *Karana Tilaka* is mentioned by name twice,[33] and though both of them are included in Al-Beruni's own list of his works which he drew up in 427 A.H./1035-36, it is not mentioned when he undertook to compose them or completed them. According to Syed Hasan Barani, *Ifrad al-Maqal* was written by Al-Beruni in 413 A.H.[34] If so, it would indicate that Al-Beruni had the text of *Karana Tilaka* with him prior to or in the year 413 A.H./1022 A.D., and though he translated some extracts from it, further work on it remained deferred. Three years later in 416 A.H. when he wrote his *Tahdid*, he explained his method of working on the different research projects, thus: *to be content with recording all the necessary information in the first instance, and then returning to the subject at the next best opportunity to complete it in details.*[35]

It may be presumed that when this statement was made (in 416), it applied, among others, to Al-Beruni's initial work on *Karana Tilaka* the completion of which till then (416) had remained deferred.

It is in *Kitab al-Hind* that Al-Beruni has quoted from *Karana Tilaka* more copiously for the first time. *Kitab al-Hind* was taken in hand and completed by Al-Beruni in 1030 A.D., most probably during the period extending from April 30 to September 30.[36] This would mean that he had translated a number of selected extracts from *Karana Tilaka* before or during the composition of *Kitab al-Hind*. He also quotes from it in *al-Qanun al-Mas'udi* which was compiled during the period 421-427 H.(1030-1035/36).[37] But since he does not mention *Karana Tilaka* in the list of his completed works which he drew up in 427 H./1035-36 A. D., it is to be presumed that he had not translated the whole work up till 1035/36 A.D.

This leads one to conclude that he might have translated it after 427 H./1035-36, sometime during the last 16 years of his life when, among others, he also wrote two of his other important works, the one on Minerals and Precious Stones (*Kitab al-Jamahir*) in 432 A.H., and the other on Materia Medica (*Kitab al-Saidanah*) in 442 A.H. when he was above eighty years old.

Such a conclusion is also suggested by his words (كنت وجدت في الهند) in the Preface which tend to denote the sense of 'once upon a time', i.e. the discovery of *Karana Tilaka in the long past when he used to visit Hind* for research. As he had already quoted this work in at least four of his publications which, by then had received a wide circulation, the reading circle of his friends suggested to him to translate the whole of it. It was at *their persuasion* that he undertook its translation, and that he translated the text *as it was* (على وجهه) without questioning the data presented, i.e. the figures given or the calculations made.

Al-Beruni's Translation: The Method

The translation of *Karana Tilaka* into Arabic is a part of Al-Beruni's Indian studies. According to Sachau, he wrote "about twenty books on India, both translations and original compositions, and a number of tales and legends mostly derived from the important lore of Eran and India".[38] He had completed the translations of *Lughujatkam* of Varahamihira,[39] *Sainkhya* of Kapila and the *Book of Patanjala*,[40] a treatise on loathsome diseases,[41] the story of Nelopher,[42] *Karana Tilaka* of Bijayanand (as confirmed by its existing manuscript), and parts or passages from a number of other works including the *Puranas*, *Gita* etc. which are cited in *Indica*.[43] He was engaged in translating the two Siddhāntas, *Pulisasiddhanta* of Pulisa and *Brahmasiddhanta* of Brahma-

gupta,[44] and *Brihatsamhita* of Varahamihara.[45]

Except the 'Book of Patanjala'[46] these tra slations are probably no more extant and, until any fresh discovery comes to light, it is to be presumed that *Ghurrat al-Zijat*, i.e. *Karana Tilaka*, is the only other translated work of Al-Beruni which has survived.

A study of Al-Beruni's method of translation shows that he was concerned more with ideas than with words, with substance than with details, and with conveying to his reader the purpose of the original in a simple, clear and concise manner, instead of confusing him with the ambiguities of the original phraseology. As a man of ideas, he did not concern himself with mere verbal translation: he aimed mainly at projecting the underlying principles, and explaining and understanding them. His "translations are never literal. He either summarises the main points in various verses, or sometimes adds an explanatory note in order to make it intelligible to his reader."[47]

Two aspects of his translation method stand out prominently: he communicates ideas in a systematic manner, and he evaluates the original subject matter to sift what is doubtful and to confirm what is correct and authentic. For the latter purpose, he would criticise the original text for any corruptions due to the carelessness of the copyists, discuss the various readings and propose emendation, point out the lacunae if any, and would blame faulty translation.[48] No such discerning remarks are, however, found in *Ghurrat al-Zijat*. This leads one to conclude that he had most probably postponed the critical ed ion of this initial draft to a later date when he could secure a more authentic copy of the work for collation and correction.

In his Introduction, he records his method of conveying the purport of the book as follows:

> "I have translated it (the text) *as it is*, except that I have explained (the reasoning behind) some of its premises, so that the proof is clearly established. In doing so, however, I have added nothing to the text but the illustrative examples in order to facilitate comprehension."[49]

Under most of the sections, Al-Beruni gives the text and then illustrates. Sometimes,[50] however, he explains the underlying concept first and then proceeds with the substance of the text.

Al-Beruni's Translation: The Present Text

The present text of *Ghurrat al-Zijat* contains some discrepancies which may be mainly due to the original text used by Al-Beruni. That he himself had doubts about the text is indicated by his introductory statement to the effect that "I have translated it *as it is*". So, Rizvi is right in his assumption that "the Sanskrit manuscript possessed by Beruni seems to be carelessly written and Beruni has copied the same figures in his translation without verification".[51] Al-Beruni has faithfully reproduced not only the figures but even the 'Table of the Yogas' as originally given by the author of *Karana Tilaka*,[52] though he knew of the more standard Table of the Yogas and had cited the same in *Indica*.[53] It would seem that some of the other assumptions, formulae and calculations which represent a deviation[54] are typical of *Karana Tilaka* itself rather than being any misconceptions or mistakes on the part of Al-Beruni.

In some cases, the original translation of Al-Beruni himself would appear to have suffered at the hands of the copyists

subsequently. This is evident from such discrepancies as are too obvious to escape notice. For example, in his *Indica*[55] Al-Beruni clearly equates the Hijra year 416 with the year 947 of Shaka-kala, but in the present text of *Ghurrat al-Zijat*, it is given as 948.[56] Similarly, the manuscript has "Thursday, 25 (كه) of Safar",[57] though 'Thursday' fell on the 27th of Safar; obviously, 'كز' was written 'كه' by one of the later copyists.

Then there are some discrepancies in the calculations given in the illustrative examples supplied by Al-Beruni himself, such as the calculation of the اصل (The Day-Number or Ahargana) as 21614[58] instead of 21586; or the use of 'diameter'[59] instead of 'circumference' of the earth for finding out the longitude of a place. Rizvi has discussed these discrepancies in details in his commentary,[60] and since these are obtained in the illustrative examples cited by Al-Beruni himself, may it be presumed that these lapses were due to the infirmities of his old age?— a circumstantial evidence which would tend to confirm that he translated the whole work finally in the very last years of his life.

PART II: THE PERSPECTIVE OF AL-BERUNI'S INDIAN STUDIES

Sachau had rightly remarked that Al-Beruni's Indian studies represented a scientific renaissance[61] of what was achieved by his early predecessors at Baghdad. The 'Ghazna-Hind' phase of the Indo-Muslim scholarship was, no doubt, the continuation, and the fruitful completion, of the pioneering 'Baghdad-Sind' based researches initiated three centuries earlier in the eighth century A.D.

Foundational Stage for Research Set in Sind

The conquest of Sind (712 A.D.) and the constitution of the 'Al-Sind' Province as an integral part of the Umayyid and

the Abbasid caliphates had, among others, generated educational activity on the new soil which brought under study local culture, languages and literature. Though the process commenced earlier, the foundation (112-116 H./730-734)[62] of the provincial capital of 'al-Mansurah' in the trans-Indus territory which soon became a centre of education and research, was an important event in the historical development of the Indo-Arabic studies. With the foundation of Baghdad three decades later (762 A.D.), Mansurah became an important provincial field centre on the Sindhian soil for scholarly communications with Baghdad on Indian studies.

With the consolidation of the Muslim power in Sind, it became possible to establish scholarly contacts with the two nearby centres of Hindu learning, viz. Multan and Bhillamāla. Multan was conquered by Muhammad b. al-Qasim in 713 A.D. and, since then, it developed into the second northern capital of the Al-Sind Province, only next in importance to the main capital (Alor first, and later) Mansurah in the lower Indus Valley of Sind.

Contacts with Bhillamala

Bhillamāla was the capital of the neighbouring Gurjara State to the south-east of Sind. Even before the Arab conquest of Sind (712), a sizable Muslim Arab community belonging to the Banu 'Ilāf tribe had found its way to al-Bailamān (Bhillamāla or Bhinmal) and, probably, took up their residence there temporarily. Their leader, Muhammad b. al-Hārith al-'Ilāfi, who was an intelligent and adventurous man well versed in local languages, and who enjoyed a measure of popularity with the people of Bhillamāla, appears to have established earliest contacts with the scholarly circles there.[63]

It was probably due to his influence that when Muhammad b. al-Qasim despatched his force to 'al-Bailamān', the people there did not go to war but offered allegiance and concluded a peace treaty.[64] Thus, a political link was forged between Sind and Bhillamāla which facilitated scholarly communications. Also it was probably due to Muhammad 'Ilafi's influence that sometime after 85 A.H. / 704 A.D., some of the 'Bailamāni' families accepted Islam, studied Arabic and individual scholars from them grew up as distinguished traditionists. Muhammad b. Abdul al-Rahman ibn al-Bailamāni, who died during the period 757-767 A.D., was the more distinguished scholar of Bailamani origin.[65] This first generation of the Bailamani Muslims helped the other Muslim scholars from outside to learn the local and classical Indian languages and, in particular, to study the astronomical literature which had been produced in Bhillamāla.

Amongst the Muslim scholars from outside who developed interest in the study of the Hindu Astronomy at this stage, were the members of the Arab community of the Fazarites from the Qaisite stock of Upper Mesopotamia (al-Jazirah) and the Muslim scholars of Sindhian origin.

It was some ten years after the conquest of Sind by Muhammad b. al-Qasim and the conclusion of the peace treaties with the neighbouring Hindu States, including Bhillamāla, that a distinguished member of the Fazāri community, 'Umar b. Hubairah al-Fazāri, became the Viceroy of Iraq under Yazid b. Abd al-Malik (720-24). Administration of Sind and other Eastern Provinces became his responsibility for some three years (103 H.-106 H./721-22 summer 724). Subsequently, his son Yazid served as the Viceroy of Iraq under the last Umayyid ruler Marwan (127-132 A.H./ 744-50 A.D.).

The interest of the members of the Fazari community in the affairs of Sind dated long back to their leader 'Umar's marriage with the Sindhian lady Habābah,[66] the mother of his illustrious son Yazid. Partisanship being the order of the day, the appointment of 'Umar, and later of his son, to the Viceroyalty of Iraq, gave preponderance to the Qaisites in general and the Fazarites in particular in the administration of Sind. It is to be presumed that they swelled the ranks of Junaid b. Abd al-Rehman al-Murri, an energetic commander whom 'Umar had appointed as the Governor of Sind in 105/723.

The First Official Translator

Junaid planned large scale military operations on the Indian Front, particularly against those rulers who had violated earlier treaties. At the same time he saw the need for a continued dialogue with them. To achieve this, he appointed an eminent linguist, Bukair b. Māhān of Kufah, as his official translator and interpreter, and paid him so very liberally that he made a fortune from his services in Sind.[67]

This important appointment made then for the first time reflected, inasmuch as it encouraged, a scholarly interest on the part of the Muslims to study the local languages. It was during Junaid's governorship (105-11/12 to 723-729/30) that, among others, some members of the Fazarite community and their associates appear to have become interested in the study of Sanskrit works on Astronomy. It was this early tradition founded by them which was later continued on by such distinguished scientists and linguists as Ibrahim b. Habib al-Fazari, his son Muhammad al-Fazari, Muhammad's associate Ya'qub b. Tariq and Bishr al-Fazari.[68]

Junaid achieved fresh victories in 'al-Bailamān' (Bhillamāla), 'Mālbah' (Malwa), Gujarat and elsewhere.[69]

That he specially appointed a deputy in Bhillamāla[70] indicates that during Junaid's tenure of office, Bhillamāla had come under the direct administrative control of the Governor of Sind. As a result, political, cultural and commercial[71] activities received a further impetus.

Astronomer Brahmagupta of Bhillamala

The city of Bhillamāla[72] had a flourishing tradition of astronomical studies which had been founded more recently by one of its illustrious residents. He was "Brahmagupta, the son of Jishnu of Bhillamāla".[73] Born in 598 A.D., he died at an advanced age in the last quarter of the 7th century - only about three decades before Muhammad al-'Ilafi might have first visited Bhillamāla (after 704 A.D.,), about four decades before the 'Ilafi community led by Muhammad might have taken up their residence at Bhillamāla (712 A.D.), and some five decades before Bhillamāla came under greater Arab political influence during the Governorship of Junaid (723-729 A.D.)

Brahmagupta had also written on subjects other than Astronomy, as confirmed by his treatise on poetic metres quoted by Al-Beruni, but his main contribution was in the field of Astronomy. The original texts of his following four works had reached Al-Beruni: (i) *Brahma-Siddhanta*, his first scholarly work which he wrote at the age of 30 years[74] in 628 A.D.; (ii) *Karana Khanda-Khadyaka* representing the doctrine of Aryabhata;[75] (iii) an 'emended edition' of No. (ii), entitled *Uttara Khanda-Khadyaka*, being Brahmagupta's own evaluation of Aryabhata's doctrine,[76] and (iv) his more mature and advanced work "*Critical Research on the Basis of the Canons*".[77]

Al-Beruni's chronology shows that Brahmagupta wrote his *K. Khanda-Khadyaka* in 665 A.D.[78] The work

represented the doctrine of the classical astronomer Aryabhata of Patliputra who had flourished two centuries earlier. Al-Beruni criticised Brahmagupta for his unjust criticism of Aryabhata[79], but he also recognized that Brahmagupta was "certainly the most distinguished of their astronomers".[80]

First Translation of Brahmagupta's Works in Sind

Because of this distinction, the early Muslim researchers in Sind gave preference to the study of Brahmagupta's standard works. Thus, Brahmagupta's two works *Karana Khanda-Khadyaka* and *Brahma-Sphute-Siddhanta* came under study and were translated into Arabic. The former became known as *'Alarkand'* and the latter as *'Sind-hind'* in the Muslim world.[81]

It is not known when exactly these works were translated into Arabic, but Al-Beruni has confirmed that *Zij Alarkand* and other Hindu astronomical works and their methods of calculations were the first to have reached the Islamic world.[82] Contacts with Bhillamāla which became more effective during the governorship of Junaid (723-729/30 A.D.) had paved the way for such an undertaking. By that time, the Muslim scholars of Sindhian origin conversant with the indigenous literature had become well-versed in Arabic, while those of Arab origin had developed competence in the languages of Sind and Hind. The process of education which commenced earlier in Sind had gained a further momentum with the foundation of the capital city of Mansurah (730-734). It was at the centres of learning which had developed in Mansurah by the mid thirties of the 8th century A.D. that the process of translating the local scholarly works into Arabic commenced.

K. Khanda-Khadyaka of Brahmagupta was the first important work which was translated into Arabic as *Zij Alarkand* at Mansurah in Sind. This is confirmed by Al-Beruni's references from the original Arabic translation. These references indicate that since this translation was made in Sind, explanatory notes and illustrative examples from the more familiar geographical and cultural environment of Sind were added by the translators. Two particular references are relevant in this regard.

(i) Firstly, Al-Beruni points out that in *Zij Alarkand* (i.e. in the original Arabic translation of *K. Khanda Khadyaka*), the name of the Sindhian city is written as 'Brahamanabād' (برهمناباد) which is Bahmanwā (بهمنوا) of the present (i.e. of Al-Beruni's) days, while another city is referred to as Lohāniyya (اللوهانيه) which is the present 'Loharani' (لوهاراني).[83] Now, 'Brahamanabād' and 'Lohaniyya' were most probably mentioned as local examples to make the Arabic translation more intelligible.

(ii) Secondly, while discussing the method of calculating the *ahargana* (i.e. resolution of years into months and days) Al-Beruni says:

> The following is the method of *Zij Alarkand*, according to a bad translation: "If you want to know the *arkanad*. i.e. *ahargana*, take 90, multiply it by 6, add to the product 8 and the years of the realm of Sindh, i.e., the time till the month Safar, A.H. 117, which corresponds to the Chaitra of the year 109. Substract therefrom 587, and the remainder represents the years of Shakh".[84]

Here the Arabic translator obviously wanted to further explain the method of *Khanda Khadyaka* for the calculation

of *ahargana* by an illustrative example based on the local 'Sindh Era'. Obviously, he took into account the current month/year of the Sindh Era, i.e. the year in which the Arabic translation of *Khanda Khadyaka* was then being made. This was the month of Chaitra of the year 109 S. E. corresponding to Safar 117 A.H. Al-Beruni has commented upon this method as follows:

> "I believe that the here-mentioned Shakh is identical with Saka.... The first of the month Safar which the author mentions, coincides with the eighth Daimāh of the year 103 of Yazdagird. Therefore, he makes the month Chaitra depend upon the new moon of Daimāh. However, the Persian months have since that time been in advance of real time, because the day-quarters (after the 365 complete days) have no longer been intercalated. According to the author, the era of the realm of Sindh which he mentions must precede the era of Yazdagird by six years. Accordingly, the years of this era for our gauge-year would be 405. These together with the years of the Arkand, with which the author begins, viz. 548, represent the sum of 953 years as the year of the Sakakāla. By the subtraction of that amount which the author has mentioned, it is changed into the corresponding year of the Guptakāla. The other details of this method of resolution or *ahargana* are identical with those of the method of the Khanda-khadyaka, as we have described it."[85]

It may be pointed out that the first of the month Safar 117 A.H. actually coincides with Wednesday, 15 Daimah of the year 103 of Yazdagird/2 March of the year 735 A.D./ 4 Chaitra of the year 657 Shaka-kala (past)/or 4 Chaitra of

the year 109 Sindhu-kala (past). Therefore, on the first of the month Safar 117 A.H., it was the fourth of the first month of Sindh Era 109. Thus, the first day of the Sindh Era 109 (past) fell on Sunday the first of Chaitra of 657 Shaka-kala (past)/12 Daimah of 103 Yazdagird/27 February of 735 A.D./or 28 Muharram of 117 A.H. Therefore, when the author of Alarkand says "the time till the month Safar, A.H. 117" he actually means the time a bit before Safar, i.e. upto 28 Muharram, A.H. 117.

This Sindh Era commenced in 4 A.H./626 A.D. The very first day of the Sindh Era, i.e. the first of the month Chaitra of zero Sindh Era fell on Tuesday, Ist of Chaitra of 548 Shaka-kala (past)/20 Azurmah of 7 *before* Yazdagird/ 4 March of 626 A.D./or 29 Ramazan of 4 A.H. Thus, the Sindh Era preceded the Khanda Khadyaka Era by 39 years, because it started with 548 Shaka-kala (past) while the latter started with 587 Shaka-kala (past).[86]

It has already been pointed out that Brahmagupta wrote *Karana Khanda-Khadyaka* in 665 A.D., i.e. 39 years after the commencement of the Sindh Era in 626 A.D. In case he had mentioned the year of the Sindh Era, this would have been the then current year, i.e., 40 S.E., and not the future year 109 S.E. Al-Beruni has also quoted the method as given in the original text of *Khanda-Khadyaka* but it does not mention the Sindh Era or its equivalent from the Hijra Era. It is besides the point to discuss here the circumstances which gave birth to the Sindh Era, but in all probability it commenced to commemorate the victory achieved by Rai Seharās over the Persians (though he lost his life in the battle) and the ascension to the throne of his son Rai Shahi as an independent ruler of Sind no longer under the suzerainty of the Sassanid Persia.[87]

To conclude, the words "*the years of the realm of Sind, i.e. the time till the month of Safar*, 117 *H.*" are undoubtedly an addition by the original translator by way of explanation. As such, they confirm that *Karana Khanda-khadyaka* of Brahmagupta was translated into Arabic in Sind (under the new title *Alarkand*) in the year 117 A.H., i.e. 735 A.D. The second work of Brahmagupta, i.e. *Brahma-Sphute-Siddhanta*, was also translated in Sind either simultaneously or soon after the completion of *Alarkand*. No direct reference to this effect is available but the circumstantial evidence warrants such a conclusion. Both *Alarkand* and *Sindhind* are mentioned in the different sources, as the earliest available works to the Muslim scholars. The suggestion that these two works were translated during the rule of Caliph Mansur cannot be substantiated as will be discussed in the following section. In case the translation of *Alarkand* in 117/735 is accepted, the long period of full 36 years till the next recorded evidence of astronomical studies during the rule of Caliph Mansur (754-775), could not have been a period of no activity. Brahma-Siddhanta was probably translated during this period. It was the translation of these two important works during the first phase of the 'Sind based' studies which paved the way for the second phase of 'Baghdad-Sind' based research for further advances in the study of Indian Astronomy.

Presuming that a Fazarite scholar in cooperation with the Sindhian scholars of Mansurah had translated these works, he could be none else than the elder Ibrahim b. Habib Al-Fazari. After having conducted his basic work at Mansurah in Sind, he became the pioneer of Arab astronomy, and the first one who constructed astrolabes

among the Arabs. Later, as a surveyor, he also partook in the foundation of Baghdad.[88]

The Subsequent Baghdad-Sind Based Studies

After the foundation of Baghdad (762), this new capital of the Abbasid Caliphate became a nerve centre for advanced research in different fields of knowledge. Here commenced the second phase of the astronomical studies which continued till the reign of Caliph Mamun. It concerned mainly with a further understanding and exposition of Brahmagupta's two works, Karana Khand-khadyaka (*Alarkand*) and Brahma-Siddhanta (*Sind-hind*). Being a continuation of the initial translation work done in Sind, this second phase, among others, aimed at a thorough textual study of these two works and an understanding of the underlying concepts and methods of calculation employed in them. The work undertaken at Baghdad remained closely linked with continued contacts and communication with scholarly circles in Sind.

During this second phase, the key role was played by Ibrahim Al-Fazari's son, Muhammad,[89] who had distinguished himself as the court astronomer of Caliph Mansur (754-75 A.D.) and who became the leading astronomer of Baghdad in his own times. Abu Abdullah Muhammad b. Ibrahim Al-Fazari and his associates, among whom Ya'qub b. Tāriq was the most distinguished one, were the rising generation of the Arab astronomers who continued their researches into the concepts, theories and methods of Indian astronomy. Beside using the available translations, they extended the scope of their inquiries by establishing contacts with scholars from Sind. Their younger contemporary, Abu al-Hasan of Ahwāz, was another scientist engaged in the same pursuit.

According to Sachau, it is said that the Arabs got their *first information* on Indian astronomy *from the scholars who came with the embassies* from Sind to the court of Caliph Mansur.[90] This was not the case, considering that *Khanda Khadyaka* and *Brahma Siddhanta* had been translated earlier in Sind (by Ibrahim al-Fazari and his associates), and that Muhammad al-Fazari, the leading astronomer at the court of Mansur, must have already studied the two works under his father Ibrahim. It is amply confirmed that both *Alarkand* and *Sind-hind* were already available by this time to Muhammad and other scholars in Baghdad.[91] These scholars were now engaged in studying the existing Arabic translations in detail and were consulting the competent scholars from Sind for clarifications and further information.

The conditions had become favourable for such an undertaking. The Abbasid power had come to stay, and its authority was being extended to the distant most provinces. Commander Musa b. Ka'ab al-Tamimi, whom Abu al-Abbas al-Saffah (132-136/750-754) had despatched to Sind, in 134 H./751, had defeated the powerful Ummayyid governor Mansur b. Jumhur (who had then established himself as an independent ruler) and brought the entire Province under an effective administrative control.[92] As a result, commercial and cultural activities between Sind and the Centre were revived and the first official deputation from Sind had come and waited upon Caliph Abu al-Abbas just three days before his death (Sunday, 12 Dhu al-Hijjah, 136 A.H. / June, 754).[93] During the rule of Caliph Mansur the administration of Sind was further stabilized, and under the governorship of Hisham b. 'Umar al-Taghlabi, the Abbasid power reached its zenith in this eastern-most province of the Caliphate. Fresh victories were achieved and even the Gandhara country

(Peshawar) in the north was conquered by sailing an army along the Indus; frontiers were made strong and secure; law and order was firmly established; the people acknowledged the benevolent rule; economic conditions improved and prosperity prevailed in all parts of the Province.[94]

It was during the governorship of Hisham from 151 to 157 (768–774)[95] that the second deputation came from Sind and waited upon Caliph Mansur. We learn from Al-Beruni (who had read an acknowledgment to that effect in the works of Muhammad Al-Fazari and Ya'qub b. Tariq) that this deputation (*wafd*) from Sind had visited the court of Mansur in Baghdad in the year 154/771. The inclusion of a scholar well-versed in astronomy in the deputation coming from Sind might have been motivated by the court-astronomer Muhammad al-Fazari. There is yet another reference by Al-Beruni to the presence of the same scholar in Baghdad which indicates that in the year 161/777-784 a third deputation from Sind had visited Baghdad.[96] Nasr b. Muhammad (b. al-Ash'ath al-Khuza'i) had been appointed as the governor of Sind in that year, but the deputation probably had come with the blessings of his predecessor Rawh b. Hatim al-Muhallabi, an able and enlightened administrator who had been transferred subsequently to take over as the governor of (northern) Africa.

In his *Kitab al-Hind*, Al-Beruni has made some six references[97] in the context of these two deputations from Sind which need to be examined in detail.

a. In 154/771, there was definitely a deputation from Sind which had among its members a scholar of Indian astronomy whom Al-Beruni calls *al-rajl al-Hindi* or merely *al-Hindi*.[98] Taken literally, it may mean that this individual was a 'Hindu' from 'Hind'; but as this

was an official deputation from Sind, its members must have belonged to that province of the Caliphate. As such, *al-Hindi* is to be interpreted broadly as 'Indian', i.e. a non-Arab Sindhian delegate from Sind who might have been either a Hindu or a Muslim by faith.

b. Among others, three astronomers in Baghdad had held discussions with this Sindhian scholar. They were Muhammad Al-Fazari, Ya'qub b. Tariq and a younger contemporary Abu al-Hasan of Ahwāz.[99]

c. Judging from the astronomical issues under reference by Al-Beruni, it is clear that the three astronomers in Baghdad were not engaged in translating any Indian works on Astronomy; they were rather seeking from the visiting scholar further information and clarification of some specific theories of the Hindu astronomers. Thus, both Al-Fazari and Ya'qub had sought information on star cycles (*Indica*, II/15 & 19); Ya'qub had inquired about the original view (not as transmitted by Brahmagupta) of Aryabhata on the circumference of the Zodiac (I/169), on the calculation of the universal solar and *unaratra* day (II/26, 33-34) and on the Hindu tradition regarding the distances of stars (II/67); and Abu al-Hasan of Ahwāz had obtained information on the revolutions of the planets in Chaturyugas (II/19).

d. The above information was recorded by the three scholars in their own works which were before Al-Beruni. In *Indica*, they are mentioned as the *Zij* of Al-Fazari and the *Zij* of Ya'qub b. Tariq[100] (II/15); *Tarkib al-Aflak* of Ya'qub (I/168-69 & II/67), and the *Zij* of Abu al-Hasan of Ahwāz (II/19). Elsewhere Al-Beruni has also referred to *Canon* (*sic.*) of Al-Fazari[101] and to *Kitab al-'Ilal* of Ya'qub.[102]

e. After discovering some discrepancies in what Al-Fazari and Ya'qub had recorded, Al-Beruni was of the view that while *listening* to the visiting scholar they took down as they *heard* from him, and in doing so they at times misconstrued what he had actually said.[103] Pointing out the mistake committed by Ya'qub in his calculations, Al-Beruni has observed that this was because 'while translating what the Indian was explaining in *his language*',[104] Ya'qub failed to grasp the reasoning behind the method. This observation indicates that Al-Fazari and Ya'qub had not recorded or translated from any book but they had oral sessions with the visiting scholar and took down what he communicated to them verbally. If this was the case, the presumption would be that the scholar from Sind was explaining i.i Sindhi because this was the language with which the Arab scholars then were more conversant.

Sachau has made some observations in this regard which need to be reviewed. He has translated *wafd* as 'embassy' which does not portray the correct historical perspective. During the reign of Caliph Mansur, Sind was not a foreign country sending her 'embassies', but an integral part (province) of the Caliphate from which deputations came to Baghdad and waited upon the Caliph. Also Sachau styles the visiting scholar as the 'Hindu Master' of Al-Fazari and Ya'qub; but as already explained the Sindhian scholar might have been a 'Hindu' by faith but not necessarily so.

According to Sachau, the 'embassies' which came from Sind included "among them scholars, who brought along with them two books, the Brahma Siddhanta of Brahmagupta (*Sind-hind*), and his Khanda-Khadyaka (*Arkand*). With the help of these pandits, Al-Fazari, perhaps also Ya'qub Ibn Tarik,

translated them".[105] Commenting further on Al-Beruni's quotation[106] from Al-Fazari's *Canon* (*Zij al-Fazari*), Sachau observes that this Canon "was a translation of the Brahma Siddhanta of Brahmagupta".[107] The only statement in *Indica* which is likely to create the impression as if Al-Fazari had translated Brahmagupta's *Brahma Siddhanta*, occurs in the context of Al-Beruni's evaluation of the data supplied by al-Fazari and Ya'qub. Both had included in their Canons information on star cycles etc. which they had derived from the scholar member of the Sindhian Delegation. This information was based upon the theories of Aryabhata and Brahmagupta. Finding that this second hand information of Al-Fazari and Ya'qub was at variance with the original statements of Brahmagupta and Aryabhata, Al-Beruni tabulated the data on star cycles from the three sources for the purpose of comparison.[108] In the first column of his Tables, he specified (along with the names of the planets) the source of information, such as:

—Brahmagupta
—The 'translation' (*naql*) of Al-Fazari[109]
—Aryabhata

Actually, the middle entry refers to Al-Fazari's *translation of what he* (along with Ya'qub) *had heard* from the scholar delegate who was al o quoting from Brahma Siddhanta (*Sindhind al-Kabir*).[110] That in the given context Al-Beruni used the word *translation* in this sense, is clear from his following observation on the discrepancies in the calculation of the star cycles: "Is their origin due to the translation (into their own words) of Al-Fazari and Ya'qub? or to the dictation (actual words) of the Indian?"[111]

That Al-Fazari or Ya'qub b. Tariq did not translate Khanda-khadyaka or Brahma Siddhanta as a result of their

contacts with the Sindhian delegate, and that their Canons were not mere translations of any of the Indian works, is clear for the following reasons:

(*i*) The Canons of Al-Fazari and Ya'qub contained some data (e.g. the use of *pala* for *day-minutes* by Al-Fazari, and the mention of the towns of Yamkot, *Tara* within the sea, and Siddhpur by both of them) the source of which could not be verified by Al-Beruni.[112] Obviously, this data was from works other than Khanda-khadyaka or Brahma Siddhanta, both of which were known to Al-Beruni. Also they were not always reproducing the same data: there was a difference between the calculations of Ya'qub and Al-Fazari.[113]

(*ii*) Al-Beruni quotes from "a bad translation" of Alarkand but does not ascribe it either to Ya'qub or to Al- Fazari.[114] Ya'qub had not translated Alarkand but only quoted from it in his *Kitab al-Aflak* after giving his own viewpoint.[115]

(*iii*) That the Canon of Al-Fazari was not a translation of Brahma Siddhanta is confirmed by the fact that, in his Canon, Al-Fazari had rejected the figures (in *yojana* measure), given by both Brahmagupta and Pulisa, for the length of circumference and diameter of the earth.[116] Al-Fazari gave his own figure for the circumference independently.[117]

(*iv*) '*Alsindhind* or *Sindhind*' and '*Zij Alsindhind* of *Al-Fazari*' stand differentiated in the works of Al-Beruni. One quotation from Al-Fazari shows him referring to the method of *Alsindhind* and following an independent method of his own.[118]

In fact, Ya'qub's *Tarkib al-Aflak* and Al-Fazari's *Zij* or *Canon* were the first comprehensive works on Astronomy

and related subjects based on (i) a critical study of the existing Arabic versions of *Alarkand* and *S ıdhind*, (ii) their further inquiries going back to the original ιext of Brahma Siddhanta and other sources, and (iii) on their own independent views and calculations. Ya'qub's contribution extended beyond his works mentioned by Al-Beruni. He had also written on the SINE and other subjects as recorded by Ibn al-Nadim [19] who names one of his three books as *Kitab al-Zij Mahlul fi Alsindhind* (in two parts) which was probably the same *Zij* as mentioned by Al-Beruni.

Al-Fazari's work, beside new content, represented an advanced and enlarged edition of the existing Alsindhind. As such, it also came to be known as "*Zij Alsindhind of Muhammad b. Ibrahim al-Fazari*".[120] He hat incorporated in this work fresh methods and material and also explanations and calculations based on the Brahma Siddhanta of Brahmagupta which was then styled (in contrast with the Arabic 'Alsindhind') as *Alsindhind al-Kabir*. Al-Beruni records that the scholar delegate was givi g information from *Alsindhind al-Kabir*.[121] It would appear that in relation to *Alsindhind al-Kabir*, Al-Fazari's Canon also came to be called as *Zij al-Sindhind al-Kabir*[122] or *al-Sindhind al-Kubra*, while the already existing Arabic version which had been known among the Muslim scholars as *Sindhind* or *Alsindhind*[123] came to be called, in contrast, as *al-Sindhind al-Sughra*. Al-Beruni's use of the two terms, *al-Sindhind al-Kubra* and *al-Sindhind al-Sughra*,[124] signifies these connotations.

To sum up, the early 'Sind based' and the subsequent 'Baghdad-Sind based' researches centered mainly on Brahmagupta's two works, Khanada-khadya'a and Brahma

Siddhanta, and resulted in the production of the following works in Arabic:

a. *Arkand* or *Alarkand*, being an Arabic version of Khandakhadyaka made in Sind in 117/135, most probably by Ibrahim al-Fazari. It was the first book on Astronomy in Arabic which became known to the Muslim scientists.[125] Being the first attempt, this Arabic version was defective; hence, Al-Beruni called it "a bad translation".[126] It was not a literal translation of the text but a translation-cum-commentary.[127]

b. *Sindhind* or *Alsindhind*, an Arabic version (with explanations?) of Brahmagupta's Brahma Siddhanta[128] was made in Sind during the period 117-150/735-767, most probably by Ibrahim Al-Fazari. Only second to *Alarkand*, *Sindhind* was among the first source books on Hindu Astronomy which became known to the Muslim scientists. Later, in contrast with Al-Fazari's *al-Sindhind al-Kubra*, it came to be called as *al-Sindhind al-Sughra*.

c. The three works, viz. the Canon (*Zij*), *Tarkib al-Aflak* and *Kitab al-'Ilal*, of Ya'qub b. Tariq. The first two incorporated some of the theories of Alarkand and Sindhind.[129] The statements of Sindhind were further checked against the text of Brahma Siddhanta through the assistance of the Sindhian delegate.

d. The Canon (*Zij*) of Abu al-Hasan of Ahwāz, an independent work in the compilation of which inquiries were also made from the Sindhian delegate.

e. The Canon of Al-Fazari (known as *Zij Alsindhind of Al-Fazari*, *Zij al-Sindhind al-Kabir*, or *Zij al-Sindhind al-Kubra*) representing to be an enlarged edition of *Sindhind*, was compiled by Muhammad Al-Fazari in Baghdad, most probably during 770-780 A.D. He had consulted the Sindhian delegate through whom information based on Brahma Siddhanta was checked and incorporated along with Al-Fazari's own theories. In contrast with the already existing *Sindhind* which was smaller in size, *Zij Alsindhind* of Al-Fazari later came to be called as *al-Sindhind al-Kubra*. In *Tamhid al-Mustaqarr*, Al-Beruni has also referred to *Qanun al-Fazari* (sic.)[130] which, most probably, was yet another name for Al-Fazari's Canon and may be accepted as being identical with *Zij al-Fazari*.

From Baghdad to Al-Beruni

During the 9th century, beginning with the reign of Caliph Mamun (198-218 H/813-33), research in Astronomy acquired new dimensions and Baghdad became a nerve centre for the advancement of scientific knowledge. However, two specific developments turned the attention away from Hindu astronomy which had been studied so very assiduously by the Fazarites and their associates/contemporaries during the 8th century. Firstly, attention was diverted to Greek works which now came under study. Secondly, scientific studies came to be based on observation and experimentation, and since the basis of Hindu astronomy had been essentially theoretical and speculative, its study did not attract the rising generations of the scientists who marvelled in actual observation and experimentation. Further efforts to study Hindu Astronomy lost momentum mainly on that account, and not because connections between Baghdad and Sind were severed, as suggested by Sachau.[131] Sind was still an integral part of the Caliphate and remained so during the 9th century. Not only political but cultural and economic relations between Sind and Baghdad were

further strengthened and settlements of the Sindhian communities had flourished in Baghdad. Yet the enthusiasm to study the works of Hindu astronomy had subsided because of a new approach to the study of the subject.

Now onwards, the works of the two Alexandrian scholars, *Almagest* of Ptolemy and the *Canon* of Theon and the methods of calculation employed in them[132] engaged the attention of Mamun's astronomers who started conducting researches in the field of Geodesy. The experimental work involving direct measurement led to their determination of the accurate value of the arc of the meridian.[133] Being motivated by the more rewarding results derived from experimentation, the group of scientists of Baghdad in Mamun's reign and their followers developed their own theories based on observation (*irsad*) and verification of reality (*tahqiq*).

On the other hand, the model for others was either *Alsindhind* or its exposition as exemplified in *Zij Alsindhind* or *al-Sindhind al-Kubra* of Muhammad Al-Fazari. Along with *Alarkand*, *Alsindhind* was the first in time in so far as astronomical studies were concerned, and also it had been further authenticated from the original source (Brahma Siddhanta) by Muhammad Al-Fazari in his Zij edition. As compared to this authoritative codification, the views of the experimentalists lacked 'authority'. Therefore, the followers of Al-Fazari and others, placing their faith in the 'authentic' tradition, continued to elaborate their views within the framework of the great tradition of *Alsindhind* without any deviation in the sense of innovation.

In his *Tahdid*, Al-Beruni has referred to the two groups as the 'traditional followers of Alsindhind' or 'the partisans of Alsindhind', and 'the experimentalists believing in actual

observation and verification of the truth'.[134] Muhammad Al-Fazari had done a pioneering work in re-examining the theories of Alsindhind by going back to the original sources. But after him, others only used the methods which they found in Alsindhind and came out with their own 'Alsindhind canons';[135] they neither went to the original sources nor did they make any independent contributions.

Secondly, as a specialist, Al-Fazari's fondness for the original sources had extended even to the 'form of composition'. As the Hindu works were composed in the *sloka* form of verse, Al-Fazari also demonstrated his skill in composing his *al-Qasidat al-Nujumiyyah* (The Astronomical Poem) wherein he explained the method of calculating 'the past part of the day'.[136] Following his example, other authors also versified their own 'Alsindhind canons' just to conform to the tradition.[137]

Thirdly, the traditionalists were divided between themselves: there were the supporters of *al-Sindhind al-Sughra* (i.e. who believed in the authenticity of the first version) and the others who upheld the validity of *al-Sindhind al-Kubra* (i.e. the Zij Alsindhind of Muhammad Al-Fazari).[138] Thus, the traditionalists instead of making any original contribution became involved with the theology of *Alsindhind*. The extremists among them held almost a dogmatic belief in the finality of the astronomical views embodied in *Alsindhind* and defended this position in the spirit of partisanship.[139] They saw no need for any independent thinking which might be in conflict with the theories and methods of *Alsindhind*. A solitary exception among them was probably Muhammad b. Ishaq al-Sarkhasi; he recognized the importance of the theories and methods of Alsindhind,[140] but also engaged himself in a critical study of the data

derived from the Hindu sources in order to arrive at more valid conclusions. Al-Beruni informs that, in his Canon, Al-Sarkhasi had corrected the original figure of the cycles of Saturn, by undertaking fresh calculations and comparing them with the actual motion of the planet and also tallying them with astronomical observations.[141] On the whole, however, the traditionalists lost the ground, and the experimentalists turned Astronomy into a science and made contributions which transcended the methods and theories of both the Hindu and the Greek Astronomy.

Employing the scientific method of observation and verification, the experimentalists made great advances in the study of Astronomy, Geodesy and related subjects. Muhammad b. Abdul Aziz al-Hashmi (d. 187) had recorded his observations of the lunar eclipse between Baghdad and al-Raqqa, while Mamun's astronomers succeeded in finding the value of the arc of meridian by actual measurement. Of them, Habash (Ahmad b. Abdullah), as recorded by Al-Beruni, had calculated the circumference and the diameter of the earth.[142] The earlier work on the 'Sine' done by Ya'qub[143] was later carried out to its logical conclusion leading to the development and use of the Sine theorem. Observations were carried out and the latitudes of the different cities were determined. Al-Battani had recorded the latitude of Raqqa while Al-Beruni's elderly contemporary Mahmud al-Khujandi (d. 391) and Abu al-Fadl al-Harawi determined the latitude of Rayy.[144] The most advanced views were held by Al-Beruni's friend Abu Sa'id Ahmad b. Muhammad b. Abul Jalil al-Sijzi whom Al-Beruni recognized as one of the 'perfect masters of the science'. Abu Sa'id believed in the rotation of the earth on its axis, and had constructed an astrolabe on this basis.[145] There were also others who believed in the same theory.[146] Astronomer

Abu Sahl al-Quhi al-Tabari, another contemporary of Al-Beruni, used Observatory and wrote on the meteorites.[147]

Thus, the experimentalists had advanced their work in different directions, and beyond the limits of Hindu Astronomy. In his *Canon Masudicus* and other works, Al-Beruni has referred to these achievements, but no where has he mentioned that any of these scientists had turned to the study of Hindu astronomy. That study stood where Muhammad Al-Fazari and his associates in Baghdad had left it. It was after a lapse of some two centuries that it was revived at Ghaznah mainly through the initiative and enthusiasm of Al-Beruni.

Al-Beruni's Initiative at Ghaznah

By the end of the 10th century, while Baghdad still provided the main focus for scientific thought, the provincial capitals of the Sāmānids, the Buwaihids, and the Ghaznavids were developing into important centres for literary and scientific studies. With Al-Beruni's advent (408/1017), Ghaznah became a centre for scientific activity and a base from which field research was extended into the areas of Hind and Sind. Al-Beruni made it "a starting point" for his computation of longitudes of Baghdad in the west, towns of India in the south, and of other places to the north-east.[148] In Astronomy, Geodesy, Geography, Chronology etc., Al-Beruni picked up the threads where his predecessors had left, and he not only updated their information but also made his own independent contributions. For instance, Mamun's astronomers had attempted to fix the precise value of an arc of the meridian by direct measurement, while Al-Beruni beside using the direct method (at the fort of Nandana) also employed the trigonometrical formulae to

find out the radius, diameter, circumference and the volume of the Earth's globe. Thus, Al-Beruni's works epitomised the research of all his known predecessors, both the more nearer ones in time (Muslim scientists) as well as the ancient ones (Hindus and Greeks).

So far as the Indian studies were concerned, Al-Beruni and his contemporaries revived the tradition of the early Muslim scholars by going back to the original sources. The geographical proximity of the Samanid and the Ghaznavid territories with the lands of Hind and Sind facilitated contacts with scholars and peoples there. A beginning in this direction was probably made by the more immediate predecessors of Al-Beruni during the Samanid period. Al-Jaihāni, the scholarly minister of the Samanids had obtained geographical and other information on India. Bishr b. Abdul Wahhāb al-Fazari,[149] a member of the illustrious Fazarite family, had made direct inquiries about the medical herbs used in Sind. It appears from his work on materia medica (*Kitab Tafasir al-Adviyyah*) quoted by Al-Beruni, that Bishr was well versed in Sindhi language to the extent that he knew its medical terminology. Most probably, he had been in Sind[150] to compile his work on materia medica. Al-Beruni's great contemporary, Abu Sa'id al-Sijzi (of Seistan) had established contacts with scholars in Sind, noted their methods of calculation, and had informed Al-Beruni about it.[151] When Al-Beruni himself was engaged in his field research, his contemporary, 'the learned' Ahmad b. Katlaghtigin had worked out the latitudes of the Indian towns of Kārli and Thānesar.[152]

However, it was Al-Beruni who, under the more fortuitous circumstances visited the sub-continent, conducted his field researches extensively, and acquired a mastery

of Sanskrit and an acquaintance with the north-western vernaculars, including the then widely current vernacular of Sind.[153] This gave him a direct access to source books and scholars, and also an insight into the local tradition. While Ghaznah remained the base, the neighbouring territories of Hind and Sind provided men and materials for his field studies.

His Travels in Hind and Sind

It is difficult to ascertain where exactly, when or for how long, Al-Beruni had been in the different parts of Hind and Sind. He only casually mentions some of the places which he had visited, and since he does not name all the places where he had been, his itinerary cannot be confined only to those places which have been incidentally mentioned by him. It was in 1017 (408 H.) that for the first time he happened to enter Hind, and came to stay for sometime at the fort of Nandana near Jhelum.[154] It was mainly during the period of about 11 years, from the beginning of 1019 to the end of 1029, that he travelled and stayed mostly in the north-western parts now constituting Pakistan. This was in the reign of Sultan Mahmud (d. 1030) and before the compilation of *Indica* (30 April-30 Sept. 1030)[155] in which he mentions that he had seen the forts of Lauhur and Rajagiri in Kashmir,[156] and had been to, and calculated the latitudes of, Peshawar, Waihand (on the Indus), Jhelum, Fort Nandana, Sialkot, Mandakakor (between Jhelum and Lahore) and Multan.[157]

Thus, by the end of 1029 A.D. he had visited parts of the Peshawar region, of Kashmir, Western Punjab, and of the Multan region of Sind. His statement in *Indica* (after naming the places the latitudes of which he had calculated) saying "we have not travelled in their country, *beyond* the places

which we have mentioned"[158] does not mean that he had not visited any other parts or places. Here *'beyond'*, in relation to Ghaznah, implies *'eastward'*, i.e. he had not been to the lands lying eastward of Mandakakor and Multan, the two eastern-most cities in the list. He mentions the course of the river Biyah to the east of Multan;[159] and his statement about "the fortress of Rohitaka in the district of Multan which is deserted"[160] would suggest as if Al-Beruni had been eastward as far as the fort of Rohtak, but that was still in the district of Multan. The varied information recorded by him about the city of Multan shows that he had spent considerable time there.[161] He has also recorded some important facts about the region on the North-west of Multan. He mentions the confluence of the Jhelum and the Chenab rivers 50 miles above Jahrāvar,[162] and has explained it for the first time (after studying the local tradition) that the ancient Sauvira was the 'country of Jahrāvar and Multan'.[163]

Al-Beruni had, therefore, the first hand knowledge of the city of Multan and the surrounding country which for centuries before him had constituted the northern division of Sind. Whether he also travelled *southward* and visited the Lower Indus Valley of Sind is not explicitly mentioned by him, and hence the general notion that he might not have been there. Barani is rather emphatic in his conclusion that al-Beruni "knew of Sind, like other parts of India, only from the account of the people who had travelled in or beyond those regions".[164] At one place, Al-Beruni has said that the people of Multan had informed him of the month with which the people of Sind commenced their year,[165] but the varied and detailed information recorded

by him in *Indica* and *Canon* about the Lower Indus Valley indicates that he knew of Sind much more than any other part of India. Beside giving general information on history[166] and geography including the routes and the cities,[167] he has also recorded the latitudes of as many as one dozen towns of Sind.[168] His more detailed account of the course of the Indus and its deltaic mouths,[169] the Sindhian coastline,[170] and of the different Sindhian scripts and the regions in which they were used[171] shows that his knowledge of Sind was more direct than merely derived from hearsay. Some of the local words and vocabulary used by him indicate that he had an intimate knowledge of the Sindhi vernacular.[172]

Besides, the following specific references tend to confirm that Al-Beruni had travelled in the Lower Indus Valley of Sind and carried out his field researches there. (i) In his Canon he says: "If the same eclipse is observed in the territories of Sind and in Spain and its time is recorded at both the places as we have explained, it will become clear from this that the noon of Sind is the sunrise of Spain while their (Spaniards) noon is the sunset of Sind".[173] Probably, it was his familiarity with the 'territories of Sind' which impelled him to cite the example. It remains to be confirmed if he actually observed a sun-eclipse there during 1019-1029 or later which was also visible in Spain and Al-Beruni's inquiries suggested the above generalization. (ii) In *Ifrad al-Maqal*, after explaining the correct method of finding out the 'Mid-day shadow on any given day', Al-Beruni refers to the (less accurate) method of calculation adopted by the Hindus, and says:

> What I heard from them is that first a given number known as *"stoga"*(?) is obtained for each latitude. This

'number' for the country of Sind of which the latitude is less than 30 degrees is 36; for the country of Lohāwar which has the latitude of about 32 degrees, it is 38."[174]

This specific reference only to the two regions indicates that he got his figures in response to his inquiries in each region. (iii) 'Sadusān' was the name of the present town of Sehwan in Sind and the country around it, which was also called Sewistān. Sadusān is mentioned in the 'Books of Conquest' (*Futuh*),[175] but Al-Beruni was the first to explain, after personal knowledge of the local tradition, that "Sadusān is Sewistān".[176] Similarly, he has identified 'Brahmanvarta' and 'Lohāniyye' (the two towns of Sind mentioned in *Alarkand*) with Bahmanvā and Lohārāni of his days.[177] (iv) Talking of the *linga* worship and its idol, Al-Beruni observes: "In the south-west of Sind this idol is frequently met with in the houses destined for the worship of the Hindus".[178] This observation appears to be Al-Beruni's own, unless he was informed by Abu Nasr who had visited the country.[179] (v) In *Kitab al-Saidanah*, while writing about the 'Ghasnaf' tree he quotes the Arab sources and then says: "The residents of the Mansurah city said that the inhabitants of Uman, Siraf, and Basrah called it *al-Khaus al-Mukari*. The residents of the Mansurah city, however, call it *Ghasnaf*, while in Sindhi language it is known as *Qulanj*".[180] This is a more direct reference indicating that Al-Beruni had been to the city of Mansurah, then the capital of the Lower Indus Valley of Sind. (vi) Beside the knowledge of Sindhi language, Al-Beruni had also acquired an intimate knowledge of the numerals and the system of counting which prevailed in Sind, as distinct from the one which was in vogue in Hind. It was on the basis of this specialized knowledge acquired in Sind and Hind, and not on the basis of any hearsay

report, that he wrote a comparative treatise on the two systems entitled "A Treatise on Arithmetic and the System of Counting with the Cyphers of Sind and India".[181]

Al-Beruni's Contributions

Al-Beruni's researches in Hind and Sind were so vast and varied that all of them have not yet been detailed and described completely. To grasp all the dimensions of the Hindu thought, Al-Beruni deliberately set for himself the task of acquiring and studying all their writings[182] in every field of knowledge—religion, philosophy, medicine, mathematics, astronomy, prosody, poetry, grammar, lexicography and folklore.[183] In the field of Astronomy, he was able to collect the original texts on which Arabic works were based and many other writings which were not known to his predecessors. His study of these sources, combined with his mastery of Arabic and Greek works, enabled him to make, among others, the following distinct contributions:-

(a) He provided a general critique of the Arabic works, pointed out the more conspicuous mistakes and supplied corrections, and undertook a revision of some of the basic works or parts thereof.

(b) He provided a general critique of the Hindu works, corrected many of the notions of the Hindu scholars and authored some new and uptodate books for them.

(c) He advanced contemporary research in Indology in general and in Hindu Astronomy and the related subjects in particular, by a comparative study and analysis of all available sources—Arabic, Sanskrit and Greek.

(a) One of the motivating factors for Al-Beruni to go to the original sources was his discovery of the discrepancies and inconsistencies in the Arabic books which

had first come under his study. He found that some of his early predecessors had often recorded their statements on the basis of hearsay concerning both the Hindu and the Greek sources. For example:

> "Muhammad Al-Fazari had just *heard* what (the Greek author) Pulisa had said, and took it to be authentic. He was, however, more nearer to the truth than many others who, for instance, had only *heard* the name of Almagest but did not know anything about it. Some thought that he (the author of Almagest) had summarized from Alsindhind while others manipulated their own silly calculations and ascribed the same to him."[184]

Moreover, in the use of the Hindu sources on Astronomy, the lack of knowledge of language had given rise to some misconceptions. Many terms, for instance, were being used without giving their meaning or equivalents in Arabic. Says Al-Beruni:

> "I found in the works which were compiled from the Indian languages during the beginning of the Abbasid period, that the Indic terms were used without translating them or conveying their purport into Arabic".[185]

The classic example of the misunderstood words was 'Aryabhata', the name of the ancient Hindu astronomer, which both Al-Farazi and Ya'qub had, on one occasion, misunderstood to mean as 'one thousandth part' (of a measure used in Brahma Siddhanta).[186] Even *Alarkand* and *Alsindhind*, the two earliest and the most widely used books considered to be the standard texts in Astronomy, needed re-edition.

In particular, the text of Alarkand was confused due to a bad translation and, therefore, Al-Beruni turned his attention first to the preparation of a new edition of it. This he

achieved on the basis of his study of the original Sanskrit text of *Karana Khanda-Khadyaka* and other related literature, especially its further exposition in *Uttara Khanda-Khadyaka* of Brahmagupta, and its commentary *Khanda-Khadyaka-Tippa* by Balabhadra of Multan.[187] Al-Beruni prepared a thoroughly revised edition of Alarkand in which he particularly used the more modern idiom in his own style and eliminated the vague and archaic Indic terminology altogether.[188]

So far as *Brahma Siddhanta* was concerned, its exposition was available in the two different Arabic texts, the original *Alsindhind* and the *Zij Al-Sindhind* of Muhammad Al-Fazari, both of which had become controversial. As such, no purpose would have been served by editing or revising any one of them; only their original needed to be translated. It appears that some sort of draft translation of Brahma Siddhanta was made for Al-Beruni before he commenced writing his *Kitab al-Hind* but, as observed by him, some of its chapters were marred "perhaps by the fault of the translator".[189] Therefore, Al-Beruni himself undertook to translate the original Sanskrit text of Brahma Siddhanta. He had already commenced translating it when he wrote his *Kitab al-Hind* (421 H./1030) but had not yet finished it.[190] Later, during the next six years (till 427 H./1035), he wrote a special monograph on 'Method of Calculation Employed in Brahma Siddhanta'.[191] These were his concentrated and fruitful efforts towards authenticating the two main Arabic texts through revision and translation, though he had also offered correction of some specific expressions and errors under different subjects treated in Alarkand and Alsindhind, in his *Indica*, *Canon* and other works.

(b) He provided a general critique of the Hindu

works and their authors. A critical evaluation of the astronomical theories and methods of Aryabhata, Varahmihira, Brahmagupta, Balabhadra and others is frequently met with in the pages of *Indica*, but the objective is mainly to clarify rather than to condemn. As a scientist, Al-Beruni simply refuses to endorse what is unscientific or untrue. For this reason, he pays compliments to Varahmihira for supporting the truth,[192] and blames Brahmagupta for suppressing it. Al-Beruni recognizes Brahmagupta to be certainly "the most distinguished of the Hindu astronomers" with "abundance of his knowledge and the sharpness of his intellect", yet he criticises him severely for compromising his views to please the Brahman priests.[193] For the same reason he blames Balabhadra, a follower of Brahmagupta, for manipulating his observations to conform to the viewpoints of the traditionalists and the priests.[194] He severely criticises Balabhadra for the poor quality of his commentary on Brahmagupta's *Khanda-Khadyaka* by observing: "All that Balabhadra produces is foolish both in words and matter, and I cannot find why he felt himself called upon to write a commentary if he had nothing better to say."[195] From amongst the two main schools of Hindu astronomers, Al-Beruni judged Aryabhata and his followers to be more nearer to scientific truth than Brahmagupta and his followers.[196]

This kind of constructive criticism of the astronomical theories and methods of the Hindus was in itself a significant contribution to the development of scientifi thought in general, and of scientific method in particular. As an educator deeply interested in the propagation of scientific knowledge and truth, Al-Beruni set himself the task of producing sizable professional literature for the contemporary Hindu scholars to enable them to keep pace with

advancement in knowledge. To this end, he contributed more than half a dozen books by (i) translating into Sanskrit some basic Greek and the more advanced Arabic works including some of his own; (ii) by attempting an exposition and better presentation of some of the Hindu methods and theories; (iii) by producing treatises in response to specific queries from the Hindu scholars; and (iv) by writing a new book to serve as an introductory text for the study of Astronomy.[197]

(c) As a third major contribution, Al-Beruni advanced contemporary research on Indology in general and on Astronomy in particular. In Hind and Sind, wherever he went, he tried to secure and study, on every subject, books and writings which could possibly become available to him. This effort resulted in more remarkable achievements. (i) He was able to write a comprehensive work like *Kitab al-Hind* which laid the foundations of Indology; and in so far as it delineated, with scientific objectivity, the beliefs, thought, culture and the way of life of the Hindus, it laid the foundations of the science of Cultural Anthropology. (ii) In his other scientific works on different subjects, Al-Beruni used his knowledge of the traditional thought and the intellectual achievements of the various nations to present his conclusions on the basis of a comparative study and analysis. His specialized knowledge of the contributions of the Hindus (which others lacked) made his works representative of the world thought at that period. His two encyclopaedic works 'Canon Masudicus' (*al-Qanun al-Mas'udi*) and 'Chronology of Ancient Nations' (*al-Athar al-Baqiyyah*) are of this stature. Also in his other works, such as *Tahdid*, *Ifrad al-Maqal*, *Istakhiraj al-Awtar* and *Tamhid al-Mustaqarr*, Greek and Hindu sources are

quoted along with the more advanced views of his contemporaries, in arriving at valid conclusions. (iii) On the basis of his specialized knowledge, Al-Beruni wrote specifically on some of the technical aspects of Hindu Astronomy and Arithmetic such as the images of two eclipses, *Rashikat*, calculation of the 'present' from the 'past', the system of numerical counting and arithmetic, and the method of learning Arithmetic.[198]

Al-Beruni was primarily interested in advancing scientific knowledge and propagating the truth; he viewed his own achievements also in relation to this main objective. He was anxious to inform others and share his discovery of any new sources of knowledge with his contemporaries. Therefore, beside using the Hindu sources himself, he undertook to translate the more significant of them into Arabic, the medium of international scientific thought, in order to inform the contemporary world of science and learning.

A reference has already been made to the works which were translated or being translated by Al-Beruni,[199] and to this category belongs the present work *Karana Tilaka* or *Ghurrat al-Zijat*. The great value of this contribution lies in the fact that the original Sanskrit texts of some of the works are lost, and that they have survived, in whole or part, only in Al-Beruni's translations. For instance, astronomer Durlabha of Multan had compiled a *canon* on the calculation of the civil *ahargana* and only a leaf of it had reached Al-Beruni from which references are preserved in *Indica.*[200] Similarly, large extracts translated from *Vishnu Dharma* have survived in *Indica*;[201] and so also translations of copious extracts from 'the more ancient' and 'the more complete' *Gita* which is now lost.[202]

The Book of Patanjal and *Karana Tilaka* are the only two complete works which have survived in Al-Beruni's transla-

tions. The original of the former is lost; for Al-Beruni's "Patanjali is totally different" from the existing text, viz. '*The Yoga Aphorisms of Patanjali* with the commentary of Bhoja Raja'.[203] So also the original of *Karana Tilaka* is lost, and it has survived only in Al-Beruni's *Ghurrat al-Zijat*.

It appears that Al-Beruni was studying and translating the different Sanskrit works in advance, preparatory to the writing of *Kitab al-Hind* (*Indica*). He has given such an indication while concluding his translation of the *Book of Patanjal*'.[204] But, when he was set about to write *Indica* or was in the process of drafting some sections of it, he had realized that on some specific questions, such as the Hindu method of computation of the distances of the planets, his study was not yet complete and that it would remain so "as long as I have no facility in translating the books of the Hindus.'[205] For this reason, Al-Beruni had probably contacts in Sind, particularly with the scholars in Mansurah and Multan who were supplying him with draft translations of some of the Sanskrit works which were locally available to them. Thus, translations of at least three works - viz. *Brahma Siddhanta* (some chapters?)[206], a work of Balabhadra,[207] and *Karanasara* of Vittesvara[208] - were probably made for him at this stage, unless these were already prepared by the Muslim scholars in Sind who had continued on the earlier tradition of translations.

Al-Beruni wrote as many as 28 works on Indian subjects[209] beside many others in which he referred to these subjects. What was his circle of readers for whom he was writing? According to Sachau, "it is difficult to say what kind of readers Al-Beruni had, or expected to have, for his··· publications on Indian subjects"; but he suggests that there were circles of "educated... Muslims in Sindh, in parts of

the Panjab,... perhaps also... in Kabul... Ghaznah and parts of Afghanistan... who had an interest in getting the scientific works of India translated into Arabic, who at the same time were sufficiently familiar with the subject matter to criticise the various representations of the subject matter, and to give the preference to one, to the exclusion of the another".[210] Scholars of Sind might have been interested in Al-Beruni's works which represented a revival of the early tradition of Indian studies in Sind. Besides, there were scholars in Seistan, Iran, Iraq and elsewhere who were equally interested in the kind of scientific studies undertaken by Al-Beruni. But more near home, it was the circle of Al-Beruni's own close friends who continued to inspire and persuade him to write on Indian subjects. Thus, he wrote his monumental *Indica* at the encouragement of the learned Abu Sahl Abd al-Mun'im al-Tiflisi,[211] and he translated *Karana Tilaka* at the persuasion of his other close friends.

In his two 'illustrative examples' in the translation of *Karana Tilaka*, Al-Beruni has specifically referred to the location of "the city of Multan in the country of Sind" and based his calculations on the latitude of Multan.[212] Choice of the 'city of Multan' for his illustrative examples, may not have any special significance: any other city could have been selected. On the other hand, there might have been some cogent reasons for this choice because Al-Beruni had made Ghaznah as the starting point for his calculations. The latitude of Multan being 30 degrees according to Al-Beruni, (which was very close to the present figure of 30°-12' N) it was convenient for the purpose of calculation; also Multan was centrally located in the Indian territories of the Ghaznavid Empire. Likewise the choice might have been motivated by the thought of his readers in Sind, the scholars of Multan and Mansurah in particular.

FOOTNOTES

1. Vide *Geschichte* I/475 & *Supplement* I/822, 856 & 870.
2. Nazim, M. (i) "A Unique Manuscript on Astronomy" published in the 'Annual Report of the Archaeological Survey of India' for the year 1929/30, pp. 232-33; (ii) "Sultan Mahmud of Ghaznah", Lahore, 1931, pp. 55, 239. S. Abu Zafar Nadvi: article (in Urdu) on this *New Book of Al-Beruni*, Journal *Ma'arif*, Azamgadh,, 1931, pp. 214-16.
3. This is the considered opinion of Prof. Abdul Aziz al-Maimani
4. Text, p. 1. The reading appears to be (بجيانند بن جنوانند البانارسي). Banarasi, i.e. Varanasi or Benares.
5. (كذا) بجيانند البانارسي - *Ifrad al-Maqal*, p. 107.
6. *K. al-Hind*, pp. 121, 289, 384 & 420; *Ifrad al-Maqal*, pp. 126 & 136.
7. *Indica*, I/156 & 343; II/49 & 90.
8. Before Brahmagupta's time (7th century), '*Vasistha Siddhanta*' one of the 5 standard *Siddhantas*, mentioned by Al-Beruni as the work of Vishnu Chandra) 'was first revised by Vijyanadin and then by Vishnu Chandra'. (Keith, A. B.: *A History of Sanskrit Literature*, Reprint 1953, London, p. 521).
9. Cf. the view of Suniti Kumar Chatterji (his article "Al-Biruni And Sanskrit" in *Albiruni Commemoration Volume*, Iran Society, Calcutta, 1951, p. 91) who while referring to the phonetic characteristics of the local Prakrit vernaculars which were current in the 11th century when Al-Beruni wrote, has observed that "the use of *b* for initial and interior *v* characterised the pronunciation of the Gangetic Valley". The situation could not have been different during the life time of Bijayanand, some 50 years earlier. It may be mentioned here that so far as the name of the author's father is concerned, our text appears to have "جنوانند" (Jinyanand) though M. Nazim, followed by others, has written it 'Jayanand' (جيانند). Here again one might keep in mind Suniti Kumar

Chatterji's observation (op. cit., p. 92) for the change of Sanskrit *y* into *j* or *jn*, e.g. Al-Beruni writing *Jnjblk* for *Yajnavalkya* (i.e. *jn* for *y*).

10. Al-Beruni is particular in identifying the two different authors if they have the same name. For exmple, he takes care to differentiate between the two Aryabhatas, as 'Aryabhata the Elder' (الارجبهد الكبير) (c. 500 A.D.) and 'Aryabhata of Kusumpura' (الارجبهد الكسمپوري). Vide *Kitab al-Hind*, text, p. 311, and *Indica*, 11/327 (annotations).
11. Text, p. 1.
12. (احد المفسرين) text, p. 1; *K. al-Hind*, p. 121.
13. Vide infra, p. 8.
14. *Indica*, I/153.
15. *al-Qanun al-Mas'udi*, I/271.
16. *Ibid*, p. 970.
17. *Ibid*, pp. 528, 970.
18. *Ibid*, pp. 173, 180, 973, 976 and 1313.
19. Ibid., p. 973.
20. *Indica*, I/155 & *K. al-Hind* p. 120.
21. Loz. cit.
22. *Indica*, I/153.
23. Ibid, II/156-57.
24. The original name, by which Al-Beruni has referred to it as *Zij Karana Tilaka* or *Karana Tilaka* (Vide *K. al-Hind*, pp. 346, 384 392, 511; *al-Qanun al-Mas'udi*, p. 973; *Ifrad al-Maqal*, p. 136; & *Tamhid al-Mustaqarr*, p. 32).
25. *K. al-Hind*, p. 289 & *Ifrad al-Maqal*, pp. 136 & 152 (كرن تلك اي غرة الزيجات); *Tamhid al-Mustaqarr*, p. 27 (كرن تلك وتفسيره غرةالزيجات); & *al-Qanun'l Masudi*, p. 1313 (غرة الزيجات).
26. *K. al-Hind*, p. 121 (زيج يعرف بكرن تلک اي غرة التوابع).
27. Sachau, taking the literal meaning of *ghurrah* (غرة) as 'the blaze on the forehead of horse', translated *Karana Tilaka* rather more figuratively as "the blaze on the front of the Karanas" (*Indica* I/156).
28. "And not on Pulisa Siddhanta as believed by Dr. Sachau and Dr. Schram". *Islamic Culture*, Hyderabad Deccan, Vol. xxxvii. No. 2, April, 1963, pp. 113 & 121.

29. Ibid, p. 113.
30. Ibid, Vol. xxxix, No. 2, April 1965, pp. 146, 149-150, 162-163.
31. *Indica*, II/60.
32. *Indica*, I/314.
33. *Ifrad al-Maqal*, pp. 136 & 152; and *Tamhid al-Mustaqarr*, pp. 27 & 39.
34. *Al-Qanun al-Mas'udi*, "An Introductory Discourse on the Arabic Text" by Syed Hasan Barani, p. vii.
35. *Tahdid*, p. 17.

لكني كنت اعتمد فيما كنت أحصل على الضبط بالكتابة دون الحفظ اغتراراً بالسلامة وأمناً من الحوادث. فحين غافصتني النكبة، اتت على ما ذكرت في جملة ما أتت عليه من اجتهاداتي، ومرت "كأن لم تغن بالامس" - و ان سهل الله الاعادة، وهو عليها قدير، فلست بمتثاقل من اتمام ذلک [ص ١٧]

36. Cf. Sachau's Introduction (p. x) to *Alberuni's India* (Arabic text).
37. "It appears that it was begun sometime before 421 A.H./1030 A.D. and completed sometime after 427 A.H./1035 A.D." (Syed Hasan Barani, Introductory Discourse).
38. *Indica*, Preface p. xxxvii. Actually the number goes beyond 30. See infra, p. 68, fn. 209.
39. *Indica*, I/8 & I/158 and Sachau's Preface p. xxxvii. *Lughujatkam* was the smaller of the two books of nativities by Varahamihira, which Al-Beruni had translated. (*K. al-Hind*, p. 122).
40. *Indica*, Preface (p. xxxviii) and I/27, 30 & II/266.
41. *Ibid*, p. xxxviii.
42. حديث نيلوفر في قصة ديبستي و بربهاكر (*K. al-Hind*, p. 123).
43. *Indica*, vide 'Index' and more specifically I/29, 60, 63 and II/265.
44. *Indica*, I/154, "I have commenced translating them, but have not yet finished them".
45. *Indica*, Preface, p. xxxvii.
46. The only known manuscript of which is preserved in the Kupreli-zada Library, Istanbul (No. 68/1589). It is a brief work with an introductory statement to the effect that Al-Beruni translated it into

Arabic "كتاب باتنجل الهندي في الخلاص في الاشتال نقل ابي الريحان محمد بن احمد البيروني الي العربي". In manuscript No. 2458: 7/2933 of the Nur Uthmaniyyah Library (Istanbul), I came across one folio entitled جدول السهام ascribed to Al-Beruni. It needs to be verified whether it is a part of an original work or a translation.

47. Cf. Dani, Ahmad Hasan: "Al-Beruni on Sanskrit Literature", article published in the *Journal of the Pakistan Historical Society*, 'Vol. I, Part IV, 1953, Karachi, p. 301.

48. *Indica*, Preface, p. xxvi.

49. Text, p. 1.

50. As in the Section (معرفة الكرنات) on p. 28.

51. *Islamic Culture*, the issue of April, 1963, p. 121.

52. Text, p. 28, which tends to indicate as if Al-Beruni himself is recounting the names and number of the Yogas. He is, however, reproducing them from the original text of *Karana Tilaka*. In *K. al-Hind* (pp. 513-14) he has clearly stated that 27 (sic) Yogas are recorded in *Karana Tilaka*:

"و ذكر في زيج كرن تلک جوكات سبعة و عشرون."

In the present text their number is 28.

53. *K. al-Hind*, pp. 513-14.

54. These have been studied and explained in detail by Rizvi in his commentary.

55. *Indica*, II/9.

56. Text, p. 3.

57. Loz. cit.

58. Text, pp. 3-4.

59. Loz. cit.

60. For details see Rizvi's commentary *Islamic Culture*, April 1963-April 1965. Some of the discrepancies which Rizvi calls 'mistakes' of Al-Beruni might be part of the original text faithfully translated by Al-Beruni. Also some of the detailed calculations might have been made for Al-Beruni by his assistants while he had to deal with varied and elaborate data. His associates helped him in his advanced age, as al-Nahsha'i did in case of *Kitab al-Saidanah*.

Kramers while examining the detailed calculations presented by Al-Beruni in the determination of geographical longitude by measuring the distances between two places, has explained that the "inconsistency in the calculations must perhaps not be attributed to the great scholar himself, but should be seen as springing from the necessity in which he found himself to exploit his huge mass of material." (J. H. Kramers: "Al-Biruni's Determination of Geographical Longitude by Measuring the Distances", being an article in *Albiruni Commemoration Volume*, Iran Society, Calcutta, 1951, p. 193).

61. *Indica*, Preface, p. xxxvii.

62. al-Baladhuri (*Futuh al-Buldan*, p. 444) has made a special mention of the foundation of al-Mans ah by 'Amr (the son of Muhammad b. al-Qasim) during the governorship of al-Hakam b. 'Awanah al-Kalbi (112-124 A.H.) under whom 'Amr was serving as a commander. It was named *al-Mansurah* in order to commemorate the victories achieved in Sind. Numismatic evidence shows that al-Mansurah had quickly developed into an important city and had already become the new mint centre in Sind by the year 116/734-5. A copper coin struck during this year with clear legend on obverse and reverse, has come to light and is preserved in the British Museum (John Walker: *A Catalogue of the Arab - Byzantine and Post-Reform Umaiyad Coins*, Vol. II, 1956, No. 927, p. 281).

63. Two brothers, Muhammad and Mu'awiyyah (the sons of al-Harith), headed the contingent of their men of the Banu 'Ilaf tribe in the Muslim army which was fighting on the Makran front. Due to a tribal feud they rebelled, killed the Commander-in-Chief Sa'id b. Aslam al-Kilabi, and for some time held sway over the Front. By about 85 A.H./704 A.D. they fled to Sind and joined the ranks of Dahar. Muhammad served as a trusted adviser to Dahar and saved the throne for him by planning the strategy and plunging his 500 men into the battle against the ruler of 'Ramal' (lit. 'Desert Country' which probably covered the northern Jodhpur & Bikaner territories) who had attacked Dahar. After victory, Muhammad rose into prominence, probably served as an emissary of Dahar to Bhillamala and achieved a measure of popularity there. In 93/712, when Muhammad b. al-Qasim was still on the western side of

the Indus, Muhammad 'Ilafi advised Dahar to cross over the Indus and contain the Arab army on the western bank. Dahar did not accept his advice, and being disappointed he later excused himself from carrying out an intelligence mission against the Arab army which had by then crossed over the Indus to the eastern side. On being ordered by Dahar to leave Sind, Muhammad left for 'Bailaman' (Bhillamala) and probably took up his residence there with his men, till Muhammad b. al-Qasim granted amnesty to him and sent him as an ambassador to the rulers in the different parts of India. The Prince of Bailaman was the first to accept Islam. (cf. al-Baladhuri, *Futuh al-Buldan*, p. 435; *Fathnamah* alias *Chachnamah*, Persian Text, pp. 69-72, 138-140 & 160-161; Sindhi edition pp. 95-97, 198-201, 231-37 & 224-25).

64. al-Baladhuri, *Futuh al-Buldan*, p. 440.

65. His full name was (محمد بن عبدالرحمان ابن البيلماني). Both his father and uncle had embraced Islam and were well versed in Hadith, and young Muhammad narrated Hadith from them. He was a client of the House of 'Umar, and had later settled down in Kufa. Bukhari in *al-Tarikh al-Saghir* includes his name among those traditionists who died between 140-150 A.H. He is mentioned by Nasai in *Kitab al-Du'afa*, by *Ibn Hajar* in *Tahdhib al-Tahdhib*, and by Yaqut in *Mu'jam al-Buldan* (بيلمان). Yaqut also mentions another eminent Bailamani traditionist Muhammad b. Ibrahim al-Bailamani, from whom 'Ubaidullah b. al-Abbas b. al-Rabi' al-Najrani had heard the Hadith. (نجران).

66. Ibn S'ad, *Tabaqat*.

67. Cf. Tabari, II/1467; *al-Akhbar al-Tiwal*, p. 335; Ibn Khaldun, *History*, III/101.

68. Vide infra, pp. 23-24, 27.

69. al-Ya'qubi, *al-Tarikh*, Beirut, 1956, III/50.

70. al-Baladhuri, *Futuh al-Buldan*, p. 442.

71. Among other imports, the Bhillamala made swords (السيوف البيلمانية) noted by al-Baladhuri became widely known in the lands of the Caliphate. (Cf. Yaqut, *Mu'jam al-Buldan* under 'البيلمان').

72. 'al-Bailaman' (البيلمان) of al-Baladhuri (*Futuh al-Buldan*, p. 435) and 'Belman' (بيلمان) of *Fathnamah-i-Sind* alias *Chachnamah* (Persian Text, Hyderabad Deccan, 1358 H./1939, p. 161; and the annotated Sindhi edition, Sindhi Adabi Board, Hyderabad Sind, 1954, p. 332) was the same as 'Bhillamala' (بهلمال) of Al-Beruni which lay between Multan and Anhalwara (*Indica*, II/153, 267).

    It is to be identified with Bhinmal or Bhilmal to the n.w. of Mount Abu in Southern Rajasthan, which became the capital of the Gurjara Kingdom in the 6th/7th century. In 725, Nagabhatta-I of the Pratihara clan founded a new dynasty at Bhilmal. (*The Oxford History of India*, 3rd. ed., reprint 1961, pp. 179, 199 & 275).

73. *Indica*, I/153 & 167. Al-Beruni gives his full name as برهمگوپت ابن جشن البهلمالي or برهمو گپت بن جشن في مدينة بهلمال (*K. al-Hind*, pp. 118 & 222).

74. *Indica*, II/12.

75. *Indica*, I/156.

76. *Indica*, I/156 & 312.

77. *Indica*, I/370.

78. Vide *K. al-Hind*, p. 346, & *Indica*, II/7.
    Karana Khanda-Khadyaka's year = -366.
    Karana Tilaka's year = 65.
    Difference = 301.
    Karana Tilaka written in = 966 A.D.
    Therefore, K.K.K. written in 966-301 = 665 A D.

79. *Indica*, I/376.

80. *Indica*, II/110.

81. *Indica*, II/187 & 304.

82. Cf. *Ifrad al-Maqal*, p. 106.
    "الدائره" هوالمعروف بالدائره" الهندية لانها في زيج الاركند و زيجات الهند و حساباتهم اول ما وقع الى مملكه" الاسلام"

83. *K. al-Hind*, p. 269 & *Indica*, I/316; *K. al-Jamahir*, p. 48.

84. *Indica*, II/48 & *K. al-Hind*, p. 383.

85. *K. al-Hind*, p. 384 & *Indica*, II/49.

86. At my request, the above dates were worked out for me by Saiyid Samad Hussain Rizvi.

87. The only source of information on the Rai dynasty of Sind is *Fathnamah-i-Sind* in which the chronology of the events of the pre-Islamic dynasties of Sind remains confused. However, the Persian invasion of Sind from Saistan and the heroic defence by Rai Seharas stands out as the memorable event of this period to mark the beginning of a new calendar for an independent Sindhian kingdom. (For the Rai Dynasty, see *Fathnamah-i-Sind* alias *Chachnamah*, pp. 14-15).

88. *Indica*, II/310 (annotation, note on page 165).

89. The distinctive roles of the father and the son are not yet clearly established. Nallino identifies 'Alfazari' with 'Ibrahim b. Habib', while according to others he was 'Muhammad b. Ibrahim'.

90. *Indica*, II/313 (annotations).

91. In his Zij, Muhammad has referred to *Alsindhind*. (See below footnote 118).

92. al-Baladhuri: *Futuh al-Buldan*, p. 444. The echo of Musa's successes in Sind resounded long after he was dead, and Jahiz had recalled the event by exclaiming "Who could conquer Sind but Musa b. K'ab!" (من فتح السند الا موسى بن كعب).
[Selections from the Epistles of Jahiz (*Mukhtar Rasa'il al-Jahiz*) printed on the margin of *al-Kamil* of al-Mubarrad, Vol. I, p. 197].

93. *Tarikh al-Ya'qubi*, ed. Houtsma 1883, vol. II, pp. 233-34.

94. *Ibid*, II/248-49. al-Baladhuri (*Futuh al-Buldan*, p. 445) has summed up the achievements of Hisham as follows:
فاخصبت البلاد في ولايته فتبركوا به و دوخ الثغر واحكم اموره

95. al-Tabari, *Tarikh*, vol. III, pp. 359-380.

96. In this year (161/777) there is a reference to the contacts with the 'scholar' but there is no mention of the 'Deputation' (*K. al-Hind*, p. 397 & *Indica*, II/67). There was yet another Deputation from Sind (preceding this one) in 156/773 according to al-Husain b. Muhammad Ibn al-Adami, as pointed out by Sachau (*Indica*, II/313) on the authority of Gildemeister (*Scriptorum Arabum de rebus Indicis loci*, p. 101).

97. *K. al-Hind*, pp. 132, 351-52, 356-57, 370 & 397 (*Indica*, I/168-69, II/15, II/18-19, II/26, II/33-34 & II/67).

98. *K. al-Hind*, pp. 351, 356, 370, 397.

99. For the last one also Al-Beruni is of the view that he had got his information from 'al-Hindi' scholar (*Indica*, II/19). Abu al-Hasan of Ahwaz was a younger contemporary who later wrote criticism of Khwarazmi (d. 820), which impelled Al-Beruni to write his book كتاب الوساطة بين الاهوازي و الخوارزمي.

100. The original expression used in *Kitab al-Hind* (p. 351) is زيج الفزاري و يعقوب بن طارق (*Zij* of Al-Fazari and Ya'qub b. Tariq) which gives the impression as if it was one and the same work undertaken jointly by the two scholars. This, however, was not the case: Al-Beruni has used this expression in the sense of two separate works, i. e. زيج الفزاري و زيج يعقوب بن طارق. This is confirmed by his reference to "زيج يعقوب بن طارق" in *Tamhid al-Mustaqarr* (pp. 30 & 54). In *Ifrad al-Maqal* (p. 51), Al-Beruni refers to the "Canons" (plu.) of Al-Fazari and Ya'qub
(الفزاري و يعقوب . في زيجاتهم)

101. (كذا) "قانون الفزاري"—*Tamhid al-Mustaqarr*, p. 30.

102. كتاب العلل—*Ifrad al-Maqal*, pp. 84 & 131.

103. *Indica*, II/19-20.

104. *Ibid*, II/346.

105. *Indica*, I/xxxi (Preface), & II/313.

106. *Indica*, I/314.

107. *Indica*, II/340 (annotation on 'p. 314').

108. *Indica*, II/16-18.

109. The original words are: "نقل الفزاري" (*K. al-Hind*, pp. 352-355).

110. Cf. *Indica*, II/18 & *K. al-Hind*, p. 356.

111. *Indica*, II/15 & *K. al-Hind*, p. 352.
"أهو نقل الرجلين؟ ام هو من املاء الهندي؟"

112. *K. al-Hind*, pp. 128 & 259; *Indica*, I/165, 303.

113. *K. al-Hind*, pp. 267-269 & *Indica*, I/314-16.

114. *K. al-Hind*, p. 383 & *Indica*, II/48.

115. *K. al-Hind*, p. 269.

116. *Ifrad al-Maqal*, p. 220.

"الفزاري خالف قول برهمكوپت و قول بلس في طول تدوير و قطرالارض في جوزنات... كما ذكر في زيجه" (افرادالمقال، ص ٢٢٠)

117. *Indica*, I/167.

118. *Istakhiraj al-Awtar*, p. 133.

و ذكر الفزاري في زيج السندهند ان حل التعديل هو ان نجعل الحصه" جيبا بكردجات السندهند (استخراج الاوتار، ص ١٣٣)

See also *Tamhid al-Mustaqarr*, pp. 24-25.

119. In *Kitab al-Fihrist* (Discourse Seventh, Subject Head 'Second') Ibn al-Nadim has given the names of the three books of Ya'qub as follows:

١- كتاب تقطيع كردجات الجيب

٢- كتاب ما ارتفع من قوس نصف النهار

٣- كتاب الزيج محلول في السندهند لدرجه" درجه"

Ya'qub's work on SINE was a pioneering one on the subject.

120. *Istakhiraj al-Awtar*, pp. 20 & 133.

121. See footnote 110 above.

122. *Istakhiraj al-Awtar*, p. 156.

123. *Tahdid*, p. 82 (زيجهم المعروف بالسندهند).

124. *Tahdid*, p. 218.

125. Cf. *Ifrad al-Maqal*, p. 106; *K. al-Hind*, p. 497 & *Indica*, II/191.

126. In *Ifrad al-Maqal* (pp. 151-152) while referring to its authenticity (صحه" عمله) he draws attention to the translator's defective rendering (سوء العبارة من المترجم).

127. See p. 23 supra.

128. Al-Beruni has pointed out that 'Alsindhind' is Brahma-Siddhanta السندهند هو براهم-سدهانده (*Tamhid al-Mustaqarr*, p. 127).

129. Al-Beruni does not give much credit to Ya'qub's statements in his *Tarkib al-Aflak* purporting to be based on the original text of Khanda-Khadyaka and characterizes them as 'tales of Ibn Tariq' حكايات ابن طارق (*K. al-Hind*, p. 266).

130. *Tamhid al-Mustaqarr*, p. 30.

131. "Soon afterwards, when Sind was no longer politically dependent upon Baghdad all the intercourse ceased entirely, Arabic literature turned off into other channels." (*Indica*, vol. I, Preface, p. xxxii).

132. Al-Beruni has observed that the methods of calculation employed by the 'western' scholars are those which are given in these two works : حسابات اهل المغرب التي هي كتاب المجسطي و قانون ثاون (*Tahdid*, p. 273).

133. Al-Beruni has recounted the researches of Mamun's astronomers in his *Tahdid*, *Kitab al-Tafhim*, and *al-Qanun al-Mas'udi* (Part I). For a systematic exposition of the original statements as to how this was achieved see Barani's article in *Albiruni Commemoration Volume* entitled "Muslim Researches in Geodesy".

134. *Tahdid*, p. 27 (اصحاب السندهند بالتقليد و اصحاب الارصاد و التحقيق).

135. Al-Beruni refers to them as زيجات السند هند or ازياج السندهند (*K. al-Hind*, p. 419; *Ifrad al-Maqal*, p. 142. *Tamhid al-Mustaqarr*, pp. 31 & 419).

136. *Ifrad al-Maqal*, p. 143.

137. *Ifrad al-Maqal*, p. 142, & *Tamhid al-Mustaqarr*, p. 26. زيجات الهند منظومة لوزن لهم مسمى به شلوك-كذلك نظم بعض اصحاب زيجات الهند (افراد المقال ص ١٤٢) صاحب زيج الهرقن المعمول بالشعر اتباعا للهند في تقييد العلوم بسلوكات الشعر (تمهيد المستقر، ص ٢٦).

138. Al-Beruni calls them اصحاب السندهند الصغرى و اصحاب السندهند الكبرى (*Tahdid*, p. 218).

139. They were متعصبى السندهند (*Tahdid*, p. 273).

140. He was from amongst the اصحاب السندهند (*Tamhid al-Mustaqarr*, p. 23), and was inclined more towards the Indian viewpoint (Ibid. p. 31).

141. *Indica*, II/15-16.

142. Habash's works (e.g. *Zij al-Mumtahan* and *Kitab al-Ab'ad wa al-Ajram*) and his contributions are frequently referred to by Al-Beruni in his *Qanun*, *Tahdid* and *Kitab al-Tafhim*. He also updated Habash's *Zij* in his own work entitled

"تكميل زيج حبش بالعلل و تهذيب اعماله من الزلل"

143. See footnote 119 above.

144. Kramers, J.H.: His article in *Albiruni Commemoration Volume*, pp. 181-82.

145. As mentioned by Al-Beruni in his *Kitab Isti'ab al-Wujuh al-Mumkanah fi San'at al-Usturlab* (Ayasufiya mss. No. 2576 in Sulaimaniyyah, & mss. No. 3319 in Kitab Khana-i Milli-i Malik, Tehran.

146. Without naming Abu Sa'id but referring to him as one of المبرزين في علم الهيئة, Al-Beruni has explained his argument thus: the fact that from height heavy bodies do not fall on the earth perpendicularly but tilting on sides indicates that the earth is not stationary but it is rotating. This was also the belief of many others as pointed out by Al-Beruni in *al-Qanun al-Mas'udi.*

فاما انا فقد شاهدت احد من مال الى نصره هذا الراي من المبرزين في علم الهيئة لم يلتزم لزول الثقيل الي الارض على القطر عموداً على وجهها، بل محرفا على زوايا مختلفه لا نضبط فيه ولا نحفظ غير المسامته لان الرجل رأى للثقيل المنفصل من الارض حركتين: احداهما دوريه لما في طبيعه الجزء من ثقيل الكل في خواصه، والاخرى مستقيمه لانجذابه الى معدنه. فالثقيل اذا انفصل عن الارض تحرك باولاهما حركه توجب في الهواء لزوم المسامته الواجبه؛ واما الثاليه المستقيمه فتوجب لو تجردت وقوعه عن غرب المسامته ابدا، لكن هويته مركب منها - فلذلك لا ينحرف عن المسامته، والخط الذي ينزل عليه ليس بعمود على الارض بالحقيقه بل مائل نحو المشرق ... و لهذا من اعتقاد قوم له و ايرادهم - الخ. (القانون المسعودي، ص‌ص ٥٠-٥١).

147. Al-Beruni wrote an appraisal of Abu Sahl's theory in his "مقاله في تصفح كلام ابي سهل القوهي في الكواكب المنقضه"

148. Vide Kramers, J.H.: His article in *Albiruni Commemoration Volume*, Iran Society, Calcutta, 1951, pp. 179 & 192. Al-Beruni's calculation of longitudes between Baghdad and Ghaznah was based on his observation of the latitude of Ghaznah during the years 409-410 A.H. (20 May 1018 - 26 April 1020).

149. Bishr Al-Fazari was probably a scholar of Baghdad contemporary with the Samanid period. He is quoted frequently by Al-Beruni in his *Kitab al-Saidanah* (Mss. in the Qushun lu Oglu collection No. 149, Public Library of Bursa, Turkey. See also Max Meyerhof's article in ISIS, Vol. 37, May 1947, pp. 32-36, and H. Beveridge's article 'An unknown work of Albiruni' in *The Journal of the Royal Asiatic Society*, 1902, p. 334).

150. Most of the 70 Sindhian equivalents for the names of the different herbs and things of medical value, are cited by Al-Beruni on the authority of Bishr. Under (ماحقيل), referring to a kind of wild onion, Bishr says "The people of Sind call it قويابصل".

151. *Ifrad al-Maqal*, pp. 92-93.
و ذكر ابوسعيد انه شاهد بعض الهنود يضرب سنة في سنة - الخ.
It is not clearly mentioned to which part these scholars belonged but it would appear that since Seistan had more direct communications with Sind, Abu Sa'id had his contacts there. Says Al-Beruni: "In marching from our country to Sind we start from the country of Nimroz, i.e. the country of Sijistan, whilst marching to Hind or India proper we start from the side of Kabul" (*Indica*, I/198). Abu Sa'id had also informed Al-Beruni about the months of the people of Seistan (*Al-Athar al-Baqiyyah*, Arabic text, p. 42).

152. *Indica*, I/317.

153. In his *Kitab al-Hind*, Al-Beruni has given a number of words belonging to the north-western vernaculars which he is supposed to have studied at Ghaznah (S. K. Chatterji's article "Al-Biruni and Sanskrit" in *Albiruni Commemoration Volume*, pp. 86 & 93). According to Sachau "the vernacular of Al-Beruni is more nearly related to Sindhi than to any other of the modern Neo-Aryan languages of India". (*K. al-Hind*, Arabic text, Sachau's introduction, p. xxv; see also pp. xxiii-xxiv, & *Indica*, II/259).

154. *Tahdid*, pp. 212-13. (ولما اتفق لي المقام بقلعة ندنه من ارض هند-الخ).

155. After he had left the Nandana Fort, he was in the town of Jefur near Kabul on the 1st of Jamada I, 409 H. / 16 October 1018 (*Tahdid*, p. 88). It must be some time thereafter, in 1019, that he could have started visiting India during the reign of Sultan Mahmud who died on 30 April 1030. According to Sachau (Intro. to the Arabic Text of *K. al-Hind*, 1887, p. x), Al-Beruni compiled *Indica* between 30 April and 30 Sept. 1030. Thus, his travels must have been suspended by the end of 1029/beginning of 1030, though some subsequent visits might have taken place during the reign of Sultan Mas'ud (1030-1040). According to Abu al-Hasan al-Baihaqi, Al-Beruni travelled in the territories of Hind for (during) a period

of 40 years. و قد سافر في بلاد الهند اربعين سنة (*Tatimmah Siwan al-Hikmat*, ed. M. Shafi, Lahore, p. 63).

156. *Indica*, I/208 & 317.

157. *Indica*, I/317.

158. *Ibid*, I/318.

159. *Indica*, I/260.

160. *Ibid*, I/308. Because he was in Multan for a long time the possibility of his visit to Rohtak cannot be ruled out.

161. Vide *Indica*, I/211, 116-17, 240, 260, 300 & 302; II/145 & 184. In *Kitab al-Jamahir* (p. 254) he mentions having seen the craftsmanship of sword-making in Multan.

162. *Ibid*, I/160.

163. "Sauvira, i.e. Multan and Jahravar" (*Indica*, pp. I/300 & 302; *K. al-Hind*, p. 253 "-سوبیر مولتان وجهراور", & p. 256, (سوبیر و هوالمولتان و جهراور)

164. *Al-Qanun al-Mas'udi*, text, Syed Hasan Barani's Introduction, p. viii.

165. *Indica*, II/9.

166. *Al-Qanun al-Mas'udi*, I/156 & II/552; & *Indica*, I/162.

167. *Indica*, I/198 & 205.

168. This he did in his *Canon* (II/552 & 561-62), i.e. after he had completed *Indica*.

169. *al-Qanun al-Mas'udi*, II/552 & *Indica*, I/259-261.

170. *Indica*, I/208 & 270.

171. *Indica*, I/173.

172. For Sachau's observations on the subject, see ft. note No. 153 above. Al-Beruni has used numerous words which are common to Sindhi and some other vernaculars, but some are peculiar to Sindhi. For example, most of the names of the *tithis*, i.e. lunar days in each half month (*K. al-Hind*, pp. 499, 502 & *Indica*, II; 197); *thoohar*, a plant of the species of the *Lactaria* which abounds in Lower Sind particularly in the sandy tracts of the Tharparkar district and the hilly tract of the Dadu and the Thatta districts (*K. al-Hind*, p. 153 تو هر ; *Indica*, I/192 *Thohar*; Sindhi ٿوهر); *ramarru* meaning a 'herd' or 'multitude of animals' (*K. al-Hind*, p. 420 "كثرة العيوان المسمي برمر"; in *Indica*, II/192, Sachau mistaking 'ب+رمر' to be a composite word 'برمر', translated it as 'the multitude of animals called *bhramara*'). In *Kitab al-Saidanah* (Bursa mss. No. 149, Arabic text, of the Qushun lu Oglu collection, & Br. Museum mss. No. 5849, Persian tr.), out of about 70 Sindhian equivalents, 40 are cited on the authority of Bishr while 27 are contributed by Al-Beruni himself.

173. *al-Qanun al-Mas'udi*, Vol. I, p. 47.

و ان رصد في بلاد السند و الاندلس كسوف واحد شهد وقته فيهما
بما ذكرنا، علم منه ان نصف نهار السند مطلع الاندلس، و نصف
نهارهم مغرب السند (القانون المسعودي، ج - ۱ ص ٤٧)

174. *Ifrad al-Maqal*, p. 92.

والذي سمعته منهم هو ان يوجدالعدد المفروض لذلک في كل عرض
و يختلف باختلافها ويسمونه استوكى [كذا] وهو لارض السند و
عرضها اقل من ثلاثين جزءا ستة" و ثلاثون ولعرض لوهاور و عرضها
حول اثنين وثلاثين جزءاً ثمانية" و ثلاثون وكانه دقائق النهار
الاطول - الخ:

175. e. g. al-Baladhuri's *Futuh al-Buldan*, p. 438.

176. *al-Qanun al-Mas'udi*, Vol. II, p. 561 "سدوسان و هو سيوستان" (the text has سدوسار). This local name 'Sewistan' continued to be used in the official record and other writings till the British occupation of Sind in 1843.

177. Supra, p. 20.

178. *Indica*, II/104.

179. Abu Nasr (al-'Utbi? or Mansur b. 'Ali b. 'Iraq?) had been in the southern parts of Sind and had corresponded with Al-Beruni from there (*Kitab al-Jamahir*, p. 206).

180. و ذكر اهل المنصورة انها شجرة يقال لها 'الخوص المكري' بلسان
اهل سيراف و عمان والبصرة - و عند اهل المنصوره 'الغصنف'،
و بالسنديه" 'قلنج'- [راجع كتاب الصيدنة في الطب تحت (الغصنف)]

181. This is the title of the treatise given by Sachau in his 'Intoduction' (p. xxi) to the text of *K. al-Hind*. See also his article in the

ZDMG, 1875. The original title of the treatise is تذكرة في الحساب والعدد بارقام السند و الهند as given by Al-Beruni in his List. It is probably the same as 'كتاب الارقام' mentioned in *al-Athar al-Baqiyyah* (p. 138).

182. Cf. *Indica*, I/154. At the time of writing his *Kitab al-Hind*, Al-Beruni had not yet been able to acquire some of the astronomical texts.

183. Vide *Indica* (I/60, 63, 135, 153, 158-59 & 219-20; II/7, 86, 190, 264-66, 275 & 277) and Sachau's preface to it (pp. xxxvii-xiii).

184. *Ifrad al-Maqal*, p. 220.

محمد الفزاري . . . انه سمع يقول بلس فاخذ به . . . هو اقرب الى الصواب من امثاله الذين سمعوا سماعه اسم المجسطي ولم يعانوا شيئا منه - فبعض يزعم انه اختصر من السندهند و آخر يثبت حسابات كهذيان المصروعين و ينسبها اليه (افراد المقال ، ص ٢٢٠).

The confusion regarding the historical basis of the Greek and the Hindu sources is also reflected in the following interesting tradition recorded by Ibn al-Wadih (d. after 292 A.H.): "The very first book on the subject (Astronomy) is called by the Hindus Alsindhind, meaning "*the epoch of epochs*" (دهر الدهور). This was summarized by Aryabhata (الارجبهر) and Almagest. Then Alarkand was summarized from Aryabhata, and 'Book of Ptolemy' from Almagest. Thereafter, they compiled from these works 'Digests' (المختصرات) and 'Handbooks' (الزيجات). [*Tarikh al-Ya'qubi*, Leiden 1883, p. 93 & Beirut 1375 H./1955, Vol. I, p. 95. This same tradition is recorded almost verbatim by Al-Mas'udi (d. 346) in his *Muruj al-Dahb*]. Al-Beruni himself is of the view that the methods used earlier by Aryabhata in his works were later appropriated by Pulisa the Greek in his own Siddhanta:

كماعمل ارجبهذ في كتبه و التفاه بلس اليوناني في سدهانده (افراد المقال، ص ١٤١)

185. *Ifrad al-Maqal*, p. 141.

وقد وجدت في الكتب التي تلقف من السنه الهند في اول ايام بني العباس و ثبتت فيها الاسامي الهنديه من غير ان تترجم او ينقل معناها الى العربيه (افراد المقال، ص ١٤١).

186. *Indica*, II/18-19.

187. The internal evidence from *Indica* confirms that Al-Beruni had acquired and studied these texts which are all quoted by him. For *Karana Khanda-Khadyaka*, see *Indica*, I/312 and II/46, 60, 83-86, 116, 119; for *Uttara Khanda-Khadyaka*, I/312, and II/87, 90-91; and for Balabhadra's commentary I/225, 243-44, 273-75. 279, 317; II/70, 75, 187. Al-Beruni thinks that Balabhadra was the author of *Khanda-Khadyaka-Tippa* (I/156).

188. In the List of his own works which Al-Beruni drew up in 427/1035, he says about his new edition:

هذبت زيج الاركند وجعلته بالفاظي اذ كانت الترجمة الموجودة منه غير مفهومة والفاظ الهند فيها لحالها متروكة.

189. *Indica*, I/277.

190. *Indica*, I/154.

191. This work is mentioned by Al-Beruni in his List as:

ترجمة مافي براهم سدهانده من طرق الحساب

192. *Indica*, I/366.

193. *Indica*, II/110-112.

194. *Indica*, I/273.

195. *Indica*, I/244.

196. *Indica*, I/227.

197. (i) He translated the following works from Arabic into Sanskrit:

1. Euclid's Elements. 2. Ptolemy's Almagest 3. His own work on the construction of Astrolabe 4. His another work 'Key to Astronomy'. (Nos. 30, 31, 32, & 8 under fn. 209 below).

(ii) He wrote in Arabic No. 15 under fn. 209 below giving an exposition of the astronomical calculations based on Alsindhind.

عملت في السند هند كتابا وسميته بجوامع الموجود لخواطر الهنود

(iii) He wrote Nos. 23 & 24 under fn. 209 below in reply to queries from the scholars of Hind and Kashmir.

(iv) He wrote No. 12 under fn. 209 below to serve as the basic text for his friend Syāvabala of Kashmir.

198. Nos. 7, 11, 17, 18, 20 & 22 under fn. 209 below.

199. Vide Supra, pp. 11-12.

200. *Indica*, I/9-10 & II/54.

201. *Indica,* II/275-76 (annotations).

202. According to Sachau, "Al-Beruni seems to have used an edition of the *Bhagavad Gita* totally different from the one which we know and which also in India seems to be the only one known. It must have been more ancient because the notorious Yoga element are not found in it, and these have been recognized by the modern interpreters as interpolations of a later time. Secondly it must have been more complete, because it exhibits a number of sentences which are not found in *Bhagvad Gita*". (*Indica,* II/265, annotations).

203. *Indica,* II/263-64 (annotations).

204. "وماعمل باذن الله كتابا في حكاية" شرايعهم والابانه" عن عقايدهم والاشاره" الى مواضعاتهم و اخبارهم و بعض المعارف في ارضهم وبلادهم يكون عده" لمن رام مداخلهم و مخاطبتهم"

(*Kitab Patanjal al-Hindi,* Mss. No. "٦١/١٥٨٩" of Koprelizada Library).

205. *Indica,* II/70 (الى ان يسهل الله ترجمة كتبهم- كتاب الهند، ص ١٠٣)

206. Vide Supra, p. 45. Being a rough draft, its chapter which was before Al-Beruni was defective in translation.

207. Cf. *Indica,* II/327 (annotations).

208. *Indica,* I/156 & II/306 (annotations). Probably being a rough draft, Al-Beruni complained that "unfortunately that which we possess of the book is badly translated". (*Indica.* II/55).

209. It is not possible to determine precisely the number of works written by Al-Beruni. He has himself recorded the names of some 112 books in his *LIST,* and some more in *Kitab al-Hind* and other works. But no where are recorded the names of all his works which count up to more than 180 when references to them in all available sources and the manuscripts found in the different collections are taken into account. Similarly, it is not possible to count up precisely the works which he wrote on the Indian subjects. However, taking into account his finished and unfinished works in this category, written both in Arabic and Sanskrit for Hindus and others on all the subjects related to his Indian studies, the total number of the recorded names exceeds 30. These are:

١. كتاب ماللهند من مقوله" مقبوله" في العقل او مرذوله"
٢. ترجمه" كتاب سانک في الموجودات المحسوسه" والمعقولة (كتاب الهند، ص ٦)
٣. ترجمه" من براهم سدهانت (كتاب الهند، ص ١١٩)
٤. ترجمه" من بولس سدهانت (ايضا، ص ١١٩)
٥. ترجمه" كتاب المواليد الصغيرة لبراهمهره (ايضا، ص ١٢٢)
٦. مقاله" في مراتب الاعداد (ايضا، ص ١٣٦)
٧. مقاله" في راشيكات الهند (ايضا، ص ١٣٩)
٨. مفتاح علم الهيئه" (ص ٢٣٢)
٩. مقاله" في تحقيق منازل القمر (ايضا، ص ٣١٣)
١٠. كتاب في ذكر الكرانات (ايضا، ص ٥٠٠)
١١. خيال الكسوفين (ايضا، ص ٥١٢)
١٢. زيج كند كاتک العربي (ايضا، ص ٥١٢)
١٣. ترجمة 'برهت سمهيت' لبراهمر
١٤. تصاليف شتى في بعدالطولين و حساب دوائر الطول (كتاب الهند، ص ٢٦٨)
١٥. جوامع الموجود لخواطر الهنود في حساب التنجيم
١٦. تهذيب زيج الاركند
١٧. تذكرة في الحساب والعد بارقام السند والهند
١٨. كيفيه" رسوم الهند في تعلم الحساب
١٩. مقاله" في ان راي العرب في مراتب الاعداد اصوب من راي الهند
٢٠. مقاله" في سكلاب الاعداد
٢١. ترجمه" مافي براهم سدهاند من طرق الحساب
٢٢. مقاله" في تحصيل آلان من الزمان عند الهند
٢٣. الجوابات عن المسائل الوارده" من منجمي الهند
٢٤. الجوابات عن المسائل العشر الكشميريه"
٢٥. مقاله" في حكايه" طريق الهند في استخراج العمر
٢٦. ترجمه" حديث نيلوفر في قصه" دبيستي و پربهاكر
٢٧. ترجمة كتاب كلپ ياره
٢٨. مقاله" في باسديو الهندي عند مجيه" الادني
٢٩. ترجمه" كتاب پاتنجل في الخلاص من ارتباک
٣٠. ترجمه" كتاب اصول الهندسه" لاقليدس الى لغه" الهند

۳۱. ترجمهٔ کتاب المجسطي البطليموس الى لغهٔ الهند
۳۲. ترجمهٔ کتاب في الاصطرلاب لابي ريحان الي لغهٔ الهند
۳۳. ترجمهٔ کتاب کرن تلک یعني غره الزيجات

In view of No. 14+, the total will be 33+. Even if No. 6 and No. 19 be identical and so also No. 28 and No. 29, still the total will be 31+. The extracts translated and cited from No. 13 in *Indica* are not only numerous but also copious ones, indicating as if Al-Beruni had translated most of this work. (See *Indica*, I/pp. 117-21, 164, 167, 297 300-303, 320-21 & 389; II/66, 88, 92-95, 96-100, 103, 107-110, 113, 115, 116-17, 123-24, 145, 135-36, & 239-40).

210. *Indica*, Preface, pp. xxiii-xxiv.

211. *Indica*, Al-Beruni's Introduction, p. 7.

212. See text, pp. 18-20.

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